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# THE

# *World of Nature*

BY

H. C. KNAPP-FISHER

WITH AN INTRODUCTION

BY

E. W. MACBRIDE, D.Sc., F.R.S.

PROFESSOR OF ZOOLOGY IN THE IMPERIAL
COLLEGE OF SCIENCE, SOUTH KENSINGTON

AND ILLUSTRATIONS OF
MORE THAN 500 FORMS OF LIFE

BY

JOAN HARRISON

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# PREFACE

IN THIS BOOK the author has set himself the difficult task of making the " world of nature " intelligible to the ordinary educated person who has had no special scientific training. It should be explained however that by " nature " the author means "living nature," and the science of living nature is what the scientific man describes as " biology."

This is a daring undertaking, for there is no science so difficult as biology and yet none which is of greater importance to humanity. When the biologist visits—as we ourselves are sometimes privileged to do—the great National Physical Laboratory at Teddington, nothing strikes him more forcibly than the simplicity of the units with which the physicist has to deal. The power employed in some of the experiments is enormous and the scale on which the apparatus is constructed is huge, but the principles involved in its construction are few. But the science of life is the science of our own being, which we share with plants and animals, and though attempts have been made to analyse this " being " into simple physical principles, the only thing that can be said of such attempts is that, however promising of success they seemed at first, they have all lamentably failed in the past, and the strong probability is that they will fail in the future.

The complexity of biology has led to the invention of a multitude of technical terms—and as closer examination of

the facts reveals more and more complexity this invention is still going on. In this procedure our American cousins have been especially prominent, and to some minds the use of the newest technical names seems to indicate a greater degree of learning.

The author has made the bold effort to discard almost all technical terms and to describe the things denoted by them in ordinary English. In this effort he has been to a large extent successful, and, as the "living things" with which he deals are for the most part the inhabitants of the English countryside and seaside, the consequence is that he has produced a delightful book which may be read with profit by anyone who loves the animals and plants around him.

So enormous has been the growth of our knowledge of life in the last hundred years that no one, however exalted his scientific position, can be expert in more than one branch of it. We ourselves in our college days were much attracted by the study of botany, but to put it mildly our knowledge of it in recent years has become very rusty, and we have read with interest and profit Mr. Knapp Fisher's descriptions of our common plants and sea-weeds.

The censorious reader—expert in one branch of biology—may perhaps discover an occasional inaccuracy on the part of the author when dealing with his particular branch. But, if so, the soundness of the broad outlook on life which the author possesses is in no way affected. Huxley, who invented the word "biology," did the science the greatest disservice by teaching his students to look on animals and plants as mere "structures" or machines. He once compared the cray-fish to the rapids above Niagara, but Mr. Knapp Fisher insists on regarding animals—and possibly plants—as centres of feeling and striving much simpler but essentially similar to our own. It is from this

point of view that living beings become interesting, and in our opinion it is only from this point of view that they can be understood.

E. W. MacBride

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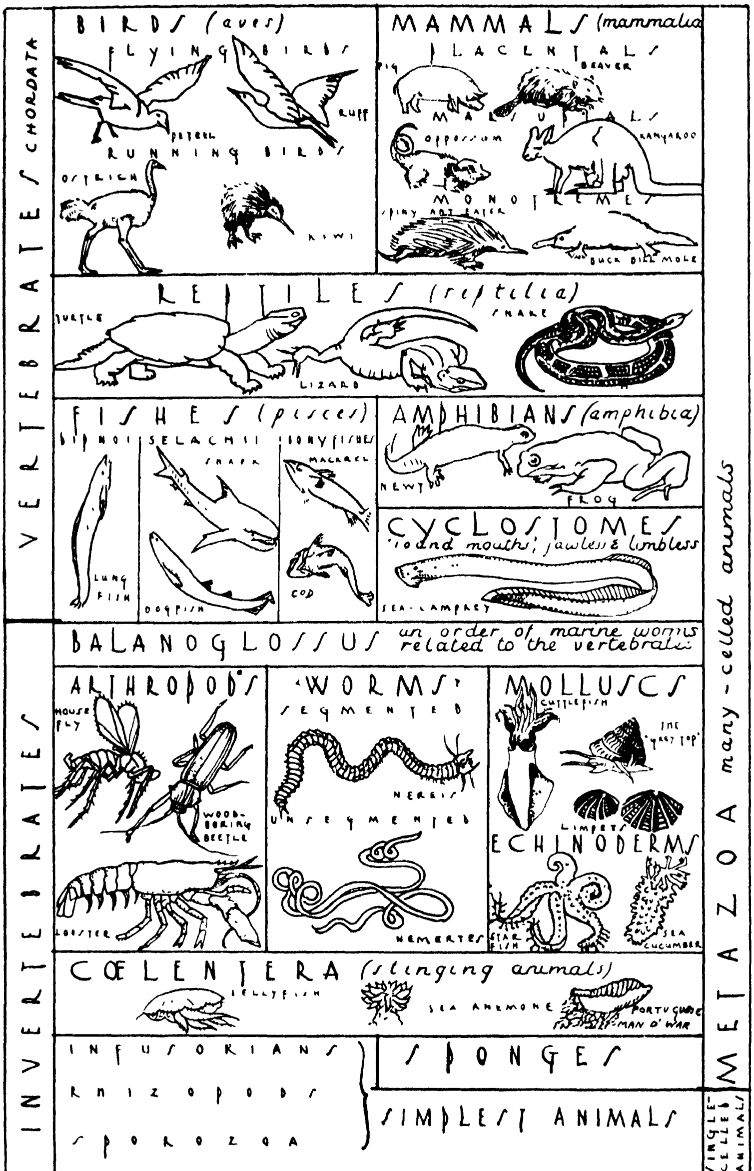
# Book One
# The Seashore

A survey of the forms of life beside the sea. The creatures of the rocks, the sea-pools, and the sands ; an account of their body-structure and their lives. " What variety of armour and of weapons ! What modes of struggle to secure self-preservation ! Of love as of hunger the shore affords many a fine illustration. Whether the earliest living creatures tenanted the shore or the open sea there can be no doubt that even in man himself there are as it were reminiscences of the school of the shore." Thus wrote Sir J. Arthur Thomson ; and this wonderful field of nature, that runs where the two great realms of life meet, is outlined in simple detail in this book. This thin line of jungle-land around our coasts teems with some of the weirdest creatures in the world of nature. As Professor Julian S. Huxley has said : " The variety and fullness of animal life can never be properly appreciated without visiting the sea-coast."




RACES (PHYLA) OF LIVING CREATURES

## CHAPTER I

# CREATURES OF THE ROCKS

THERE ARE PEOPLE who go down to the beach every day and can see no signs of animal life except the sea-birds, a few baby crabs, a scuttling worm or two, the motionless shell-fish that cling to the rocks, and perhaps the tiny creeping and jumping forms that dwell among half-dried seaweeds near the high-tide mark. Such people may find a few shrimps and prawns in the sea-pools, and now and then may glimpse, out of the tail of their eye, the wriggling dart of some small fish.

Actually the seashore has a greater number of different kinds of creatures than any section of inland country. Half a mile of beach certainly contains one thousand different sorts of living things, and on certain sections of coast the number may be nearer two thousand. How many thousands there may be of each sort is a problem that would stump a " lightning calculator."

On a sandy beach not more than a mile in length there may be as many as four million worms of a single kind. On one square foot of rock there may be as many as three thousand barnacles. The barnacles are easy to see ; the worms are buried a few inches below the surface of the sand. The shore creatures are adepts at concealing themselves ; which makes the hunt for them something of an art and an adventure.

The parts of a shore have been divided by scientists into *zones*. Each zone will usually have its special population of creatures. These zones vary, of course, according to the kinds of shore. The creatures dwelling on a rocky coast are different from those inhabiting a sandy one. These zones

are named after the plants which grow most thickly upon them. On sandy coasts in Britain, the first zone, which starts at the high-tide mark, is named after the salt-wort—Latin name, *Salicornia*, a tiny plant, not a seaweed, which has become adapted to shore life : therefore, the first zone is called the salicornian zone. The last zone is the zone of the tangle-weeds, *Laminaria*. The laminarian zone is that part of the beach *which is uncovered only at low spring tides*. This zone is far the most thickly populated by strange sea creatures, and anyone is in for a great adventure who goes down among the tangle-weeds during the two or three low spring tides, on a real expedition of exploration.

The rocks are a different proposition. They differ much more than the sands. They may be sheer cliffs or broken masses of boulders, or firm craggy headlands sloped at all angles, worn into caves and crannies, so that creatures of the rock-kinds may be found in different places on different coasts. Different sorts of rocks, too, provide homes for different sorts of creatures.

On almost any tide-washed rocks we can see countless hundreds of shells, like tiny tents—shells of winkles, mussels, limpets, and how many more ? These creatures have solved the problem of their rough home by perfecting the art of clinging.

One of the most numerous of these shell creatures is the common barnacle (*Balanus balanoides*). These barnacles cover even the most wave-swept rocks and boulders. No storms can shift them because they cement their shells to the rock. Many shell creatures can do this. They have within their tiny bodies a small round bag, or *gland*, which contains a sticky fluid that hardens into a sort of cement when it is poured forth.

On most shores the common barnacle is found chiefly on rocks in the zone between three-quarters tide and high tide. The common barnacle shells are quite small, cone-shaped, with a little hole at the top. From the hole regular ridges run down to the edge, which is thus wavy. These ridges are as sharp as knives.

As soon as the tide covers the barnacles they send a sort of hand out through the hole at the top, and this hand waves about in the flowing waters, catches minute particles of drifting food, and draws this food into the shell for the barnacle to feed upon. This " hand " is really a number of fine thread-like arms, fringed with hairs, that form a sort of net, like a tiny trawl-net. When the tide goes down again and leaves the barnacles high and dry the hand is drawn inside, a sliding roof closes over the hole, and the barnacle goes to sleep.

To most of the seashore creatures ebb tide is what night-time is to us. It is the time of silence and sleep. The incoming tide is their sunrise. Then they awake to life, to hunting and fighting. It so happens that many barnacles settle upon the zone which is only covered by the highest spring tides, or where great storms throw the waves to their utmost limit. These sea creatures must be able to sleep for days and even weeks without dying. It has been shown that a barnacle can live for forty-four days out of the sea. The age of sleep which these creatures endure is like the period of hibernation in land animals. Like the hedgehog and the insect-eating bats and other animals which sleep through the winter, the barnacle sleeps through the long night of low tide.

Another common seashore creature which is even better adapted to this strange home is the winkle (*Littorina*). There are four kinds of winkle on our shores. In order of size, they are periwinkle, smooth winkle, rough winkle and nereite winkle. Unlike the barnacle, the winkles do not remain stuck down to the rock at high tide, waiting for food to float to them. The winkles have a cloven foot on which they waddle up and down rough steep rocks, over smooth round stones, and even up and down the sandy beach, in their search for food. They lift and put forward and down each half of this foot in turn, and the walk of the winkle has been likened to the walk of a man with his ankles tied together.

The winkles are one of the many shell-fish that have

spiral shells, whorled round to a point at the top. When he is on the prowl the winkle's head sticks out boldly in front of his shell. He looks a bit like a land-snail, who is, indeed, his cousin.

If we look carefully at a winkle walking we see that he has on each side of his head a tapering horn or tentacle, like the feelers or antennae of an insect : the winkle can slide his horn in, in much the same way as you shut up a telescope. Below these feelers the winkle has his eyes. Between his eyes is a sort of wavy trunk called the *radula* or tooth-ribbon. This radula is a combination tongue-and-teeth, being studded on both sides with teeth that will scrape food off rocks and stones.

The way in which the winkle scores over the barnacle in his adaptation to his home is this : he is adapted for life as a land creature, as well as for life as a sea creature. The winkle has a gill like a fish, for breathing under the sea, and also a sort of lung like a man, for breathing in the air. The common periwinkle of the North Atlantic coasts of Britain can live *for several months* out of the sea. Of the 80 species of winkle in the world, only a few kinds have a true lung, so as to be able to live their whole life on land if need be.

The winkle, in short, is *amphibious*, a word made up from two Greek words, *amphi*, which means " both," and *bios*, which means " life " : i.e. " both lives," or " both ways of living." There are many hundreds of amphibious creatures in the world of nature, some definitely called amphibians, which we shall look at in the fourth Book in this volume. Some of the amphibious creatures of the seashore are sea creatures slowly becoming land creatures. Others would seem to have got stuck between sea-life and land-life : they enjoy some of the advantages of both ways of life ; they also suffer many of the disadvantages of both kinds of life : which may lead us to ask a question : Which is the best environment for living things, the sea or the land ?

This is a question we can answer only by carefully watching the creatures of the sea as well as the creatures of the

land. And we need to know, also, something of the marvel of living bodies, something of the way in which they feed and breathe. We shall look at these facts more clearly and closely in Chapter III.

For the moment, we return to the shell creatures upon the rocks.

The shell fish that has the greatest reputation for clinging is the limpet ; and it is quite likely that the limpet holds the record for sticking to his post. When we come to study the limpet's method of clinging, however, we are faced by an exciting fact. In the hundreds of forms of life commonly found upon any seashore there are more mysteries than in all the detective stories ever written. Day by day scientists find out more about this creature and that ; but there is a field for discovery for everyone with a pair of eyes and an ounce of patience in almost every one of the most ordinary seashore creatures. How, for instance, *does* the limpet cling ?

If you take a limpet unawares a quick tap at the right angle will tumble him off the rock as easy as winking. But tap him wrongly, and give him warning, and you will probably break his shell and kill him before you can shift him. It has been shown that a " pull " of 70 pounds is needed to lift a clinging limpet off a rock. And no one knows for certain just how he manages to cling !

It is possible that a limpet cuts a circle in the rock with the sharp edges of his round shell. Standing upon his foot he may work his shell this way and that until the sharp edge of the shell has made a round cut in the rock. Into this cut, of course, the shell fits exactly ; and when the tide goes down he can drop his shell into the cut ; and then perhaps he squeezes himself up tight inside the shell, and by so doing he may create a *vacuum* between his body and the rock. Such a patient and cunning process could well account for the limpet's firm hold.

Many scientists do not believe that this is the way the limpet clings, however, since it seems that he will still cling with great force even when the shell has been lifted and is

no longer fitted into the round cut. It has been suggested, therefore, that the real clinging part of the limpet is his foot. The foot of the limpet is not in the least like that of the winkle. It is not a cloven foot, in two parts, but a single fleshy lump, on which the limpet moves rather as a snake moves—the front part of the foot lifting while the back part still holds to the rock. The lifted part stretches forward, and comes down further on, then the middle part lifts and follows, and finally the back part of the foot releases its hold and draws up close to the rest and sinks down. This foot, we see, is like elastic, and moves, so to speak, like a wave. So wavy and elastic is the foot that when the limpet clings, possibly the foot folds round every tiny wrinkle and bump of the rock, clutches every knob and fills up tiny, almost invisible holes—so that the limpet can be said to cling to scores of little " holds."

Yet other scientists maintain that the limpet, like the barnacle, uses a sort of cement. This wonderful clinger keeps his secret tighter even than his hold upon the rock ! There are thousands of mysteries such as this on the sea-coast ; and anyone who wants to take the shore seriously might ferret out a mystery and spend every holiday trying to solve it, in the end perhaps making a real contribution to man's knowledge of the world of nature.

If we look carefully at the rocks upon which the limpets are clinging we can see what look like faint trails leading away from the limpet-shells across the slimy seaweeds. These trails have been made by the limpets themselves. When the tide covers them the limpets cease to cling to the rocks and go a-roving in search of food. As they walk they eat the seaweed and thus clear a path.

The limpets never travel far from the spot where they started—about three feet is their limit. If they go much further than three feet they are apt to lose their way, then they will have to seek out new homes. For each limpet has his own home on the rock to which he returns before the tide leaves him high and dry. The limpet becomes attached to his home on the rock in more senses than one !

At the end of this first Book we give a short list and description of a number of other shell creatures that cling to the rocks. Here we will but mention one more, that golden-brown jelly-like blob of matter living in the blue boat-shaped shell : the mussel. The winkle has a single shell like a tent. The mussel has two shells hinged together, and at high water he does not go in search of food, but holds his shells apart and lets his food drift in between them on the tide.

The mussel has a number of very fine hairs that act like oars, beating sideways all together quickly, and " feathering " slowly backwards. This action makes the water flow through the mussel's shell and the mussel's mouth gobbles up small particles of food from the water.

When the mussel *does* want to move he has, like the winkle and the limpet, a large foot to help him. It is a very queer foot, out of which grow a number of threads that have sticky discs at the end. These threads act like anchor-ropes to hold the mussel in place.

If you can imagine being tied to the rocks by your bootlaces you may gain some idea of how the mussel stands upon his foot ; but the bootlaces of the mussel are stuck down, not tied down. When the foot is lifted up the old laces break off and new laces grow out from the foot for the next foothold.

Having glanced quickly at the common barnacle, the winkle, the limpet and the mussel, let us turn scientist for a moment and take stock of what we have learned.[1] It is of little use straying from one creature to another at random ; for they are all related to one another, and scientists have worked out their table " of kindred and affinity." Even man comes into this table. Perhaps all lives on earth are related. Men and beasts and flowers of the field may be connected up in the great " genealogical table."

Scientists have given classical names to the families of living forms, and sometimes when people want to study the

[1] A more complete and properly arranged description of the shell creatures of the rocks is included in the list of shore forms at the end of this first Book (see pp. 113 to 120).

world of nature they get bored and annoyed by the long Latin and Greek names which scientists have given to them. In this respect it is useful to recall the story of an old fisherman who wanted to get a pilot's certificate.

Until he got his pilot's certificate the old fisherman was not allowed, by law, to sail his boat down a certain channel and into a particular harbour ; but the examination was a hard one, and the fisherman was handier with the halyard and the tiller than with sums in arithmetic and facts about the stars. He had never even heard the names of the stars before, and was in despair of passing his exam, when a kindly gentleman took him in hand and drummed the mathematics into him and made him learn the names of the stars.

" So you got through all right ? " said the gentleman, after the exam.

" Yes, thankee, sur," the fisherman replied. " But wot beats me," he went on, scratching his head, " is 'ow they found out the names of the stars ! "

When we first find out that the common barnacle is called *Balanus balanoides*, and the common oyster is known as *Ostroea edulis*, we may well wonder how scientists found out these names. It might hardly occur to us that people should *invent* such names. Yet this is, of course, the case.

The habit of giving Latin and Greek names to forms of life in the world of nature began in the Middle Ages, when all learned books were written in Latin, so it was natural that plants and animals should get Latin (and sometimes Greek) names. The great Swedish naturalist, Carolus Linnaeus (1707–1778), first made a careful and methodic system of this business of giving names to natural things.

Before the time of Linnaeus the Latin name was really a little sentence describing the plant or animal, but this was long-winded and difficult to remember. Linnaeus shortened it down to two words, like our Christian name and surname, but placing them the other way round.

Linnaeus started with flowers, and the method spread from plants to beasts and birds and fish and all living

creatures. There is nothing more strange in an oyster being called *Ostroea edulis* than there is in a man being called Thomas Jones.

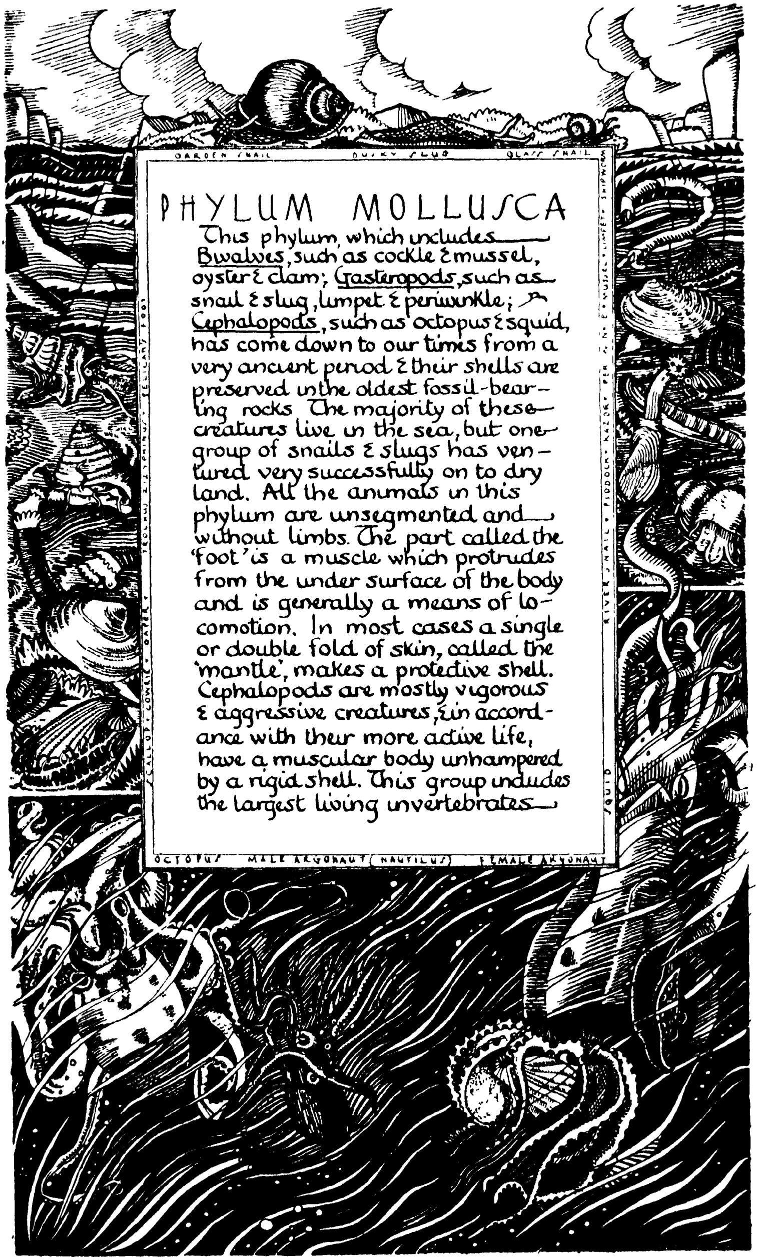
You know from the "Jones" that Thomas belongs to a certain well-known family of men; and you know from *Ostroea* that the oyster belongs to a certain species of shell-fish of the genus Ostroea.

In this way the family tree of the world of nature has been discovered and named by men. Without knowing the chief family names and the main individual names of the creatures we can no more pilot ourselves through the wonder-world of animal and plant life than the old fisherman could pilot himself through the channel without knowing the names of the stars.

Let us be clearer in our minds about it all than that fisherman was; let us see through the long classical names to the living beauty and the quivering strength of our humbler relatives of the beach and field.

In the first place let us know that scientists have grouped all animals into *phyla*. The word *phylum* comes from a Greek word meaning a "race" or "tribe." The four shell creatures at which we have looked come within two phyla. The winkles, the mussels and the limpets come into the phylum called *Mollusca*. The barnacles belong to the phylum called *Arthropoda*. This means, naturally, that the winkles, the mussels and the limpets are more closely related to each other than they are to the barnacles: indeed, they are "foreigners" to the barnacle, who is of a different race.

In the mollusca race, there are more than *sixty thousand kinds* of creatures; and these 60,000 kinds have been divided by scientists into five big families. When we say "divided by scientists" let us not fall into the error of the fisherman over the stars: we mean of course that scientists have discovered that these creatures are related in certain groups, as men are in families: remember, we said the winkle was the *cousin* of the garden snail. The winkles and snails and whelks and slugs and many other of their kindred belong to one family of molluscs, the *univalve molluscs*:




# PHYLUM MOLLUSCA

This phylum, which includes Bivalves, such as cockle & mussel, oyster & clam; Gasteropods, such as snail & slug, limpet & periwinkle; Cephalopods, such as octopus & squid, has come down to our times from a very ancient period & their shells are preserved in the oldest fossil-bearing rocks. The majority of these creatures live in the sea, but one group of snails & slugs has ventured very successfully on to dry land. All the animals in this phylum are unsegmented and without limbs. The part called the 'foot' is a muscle which protrudes from the under surface of the body and is generally a means of locomotion. In most cases a single or double fold of skin, called the 'mantle', makes a protective shell. Cephalopods are mostly vigorous & aggressive creatures, & in accordance with their more active life, have a muscular body unhampered by a rigid shell. This group includes the largest living invertebrates.

that is, molluscs with a single tent-like shell. The mussel, having two shells hinged together, is the close relative of the oysters and scallops and all the *bivalve molluscs.*

This relationship of creatures in families within phyla is more clearly shown in several of the illustrations throughout this volume, where the chief forms are shown and explained. (See, for example, the illustration, " Phylum Mollusca," on p. 22, or " Phylum Arthropoda " on p. 286.)

Most people nowadays know that the different sorts of creatures are called different *species,* and that these species are grouped into *genera.* " Species " and " genus " are names known to every school-child ; but these divisions are not the most important ones in the natural family tree. The periwinkle is a species of the genus winkle. The genus winkle belongs to the family *Gastropoda,* which means " belly-foot " ; all creatures in this family walk upon a big foot that sticks out of their middle. The family Gastropoda is one of the five great families making the phylum Mollusca.

It is quite simple. It is the *relationships* that matter, not the names : the names merely *tell* the relationship. Keep this in mind :

> Every species belongs to a genus.
> Every genus belongs to a family.
> Every family belongs to a phylum.

If those three lines are known clearly to you, nothing else in the way of Latin or Greek names need ever bother you.

Of course this simple division has sometimes to be divided up further. Think of sixty thousand forms of creatures in phylum Mollusca. Sixty thousand different kinds of creatures, differing so widely as the octopus and the slug ! The largest of the molluscs are the giant squids of the southern seas, and the smallest are some tiny snails of the garden. . . .

What infinite variety there is of form and way of life even in this one phylum ! We've met one odd character

already, the amphibious winkle. He is not an amphibian like the frog, who belongs to phylum Chordata, the great phylum to which men belong. Phylum Chordata is the race of *backboned animals*. The winkle has no backbone and is a mollusc, although he is amphibious in habit. The wonderful winkle will therefore serve to remind us that the grouping of creatures in their family tree is not a simple matter.

# CHAPTER II

# SEAWEEDS AND SEA-POOLS

PLANTS, it has been said, are producers : animals are consumers. Plants make their life out of dead minerals and gases ; whilst animals keep themselves alive by killing and eating plants and other animals. There is therefore a great cleft between plants and animals ; and seaweeds, being plants, come by rights into Book Two of this volume, where the lives of plants are examined. For a proper understanding of the place of seaweeds in the natural scheme we must await our chapters upon flowers and plant life.

We cannot avoid seaweeds on the seashore, however, so we had better look at some of the common forms before going any further. The seaweeds—they are called *Algae* by the scientists—play a big part in the life of the shore. Countless sea creatures find refuge among their damp tangled masses during low tide ; most of the seaweeds have a slimy coating which keeps them moist and cool when they are exposed to the sun on the beach, and the creatures hide in these shady nooks, like cows under the trees in the heat of the day. When the tide surges over the rocks and these same seaweeds rise up and float in the swaying waters, creatures take refuge among their stems, which act as breakwaters to the angry waves. And the seaweeds, of course, are the food of thousands of sea-beasts, ranging from the limpet and even tinier forms, to the shoals of herring and mackerel that sometimes come in with the rising tide.

Although the seaweeds are plants, they are quite unlike land plants. To begin with, they have no roots, but are

# The Sea Pool

jellyfish
prawn
shrimps
sea snail
jellyfish
squid
blenny
anemone & prawn

stuck on to the rocks by a cement which they make for the purpose. A land plant feeds partly through its roots, sucking up minerals from the soil, but a seaweed can soak into itself food from the waters of the sea, that surround it on every hand. We shall look at this again, and more clearly, in Book Two.

One of the most common kinds of seaweed on the English coasts is the genus called *wrack*. There are several kinds of wrack. Bladder-wrack, for instance, is the kind that has little air balloons growing upon it. These balloons are floats, like the rubber floats that children use before they learn to swim. These balloons aid the branches of seaweed to float in the flood tide, though the plants remain cemented by their base to the rocks.

Another difference between seaweeds and land plants is their method of *reproduction*. If we examine rather closely the tip of one of the long leaves of the seaweed called bladder-wrack we shall see many tiny knobs, no bigger than pins' heads. These sacs, as they are called,[1] contain the cells from which new plants can be made.

There are two sorts of cell within the sacs ; and these two sorts of cell grow on different plants of the bladder-wrack.

It is when these two sorts of cell meet and join together that a new plant begins to be formed.

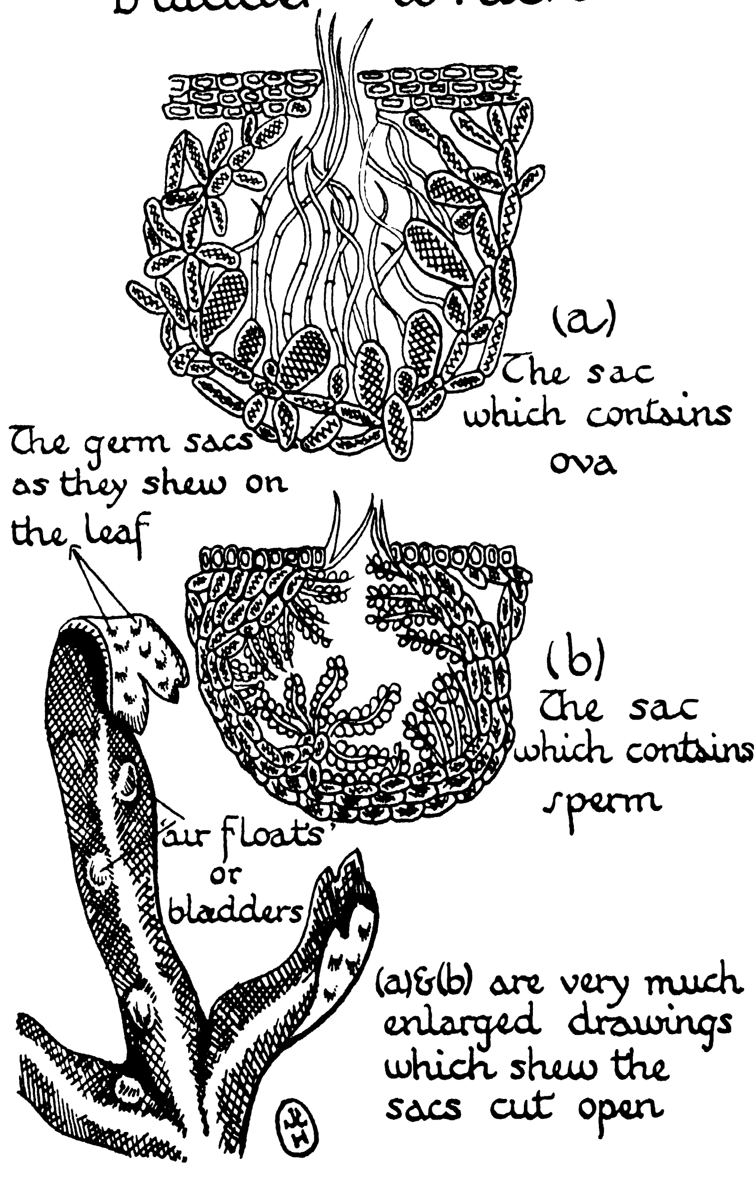
In our picture you will see two sacs, very much bigger than they are in life, and shown with one side cut open to let you see in. Here in (*a*) is one sac, containing the cells called ova—from the Latin *ovum* (" an egg "), plural *ova* ; and like little dark eggs they look, growing among the fine downy hairs inside the sac.

At the top of the sac you will see a pin-hole opening ; and when they are ripe the ova break off from the sac and swim out through the pin-hole into the open sea.

In the open sea each tiny ovum of the bladder-wrack paddles along with the aid of minute hairs, until it meets a

[1] The word *sac* is the same as " sack " ; and it is used to describe the natural sacks or pouches, the little hollow swellings, on and in many plants and animals.

# Bladder Wrack



spermatozoon, which is a big word for the small things which you can see growing inside the other sort of sac (*b*). We will call them sperms for short. They are even smaller than the ova ; and they, too, break off from their sac when they are ripe, and swim out through the pin-hole into the open sea.

When an ovum and a sperm meet they mingle to form the beginning of a new life, a new bladder-wrack plant ; and at once they sink to the sea-bed and begin to grow as a new seaweed.

No scientist has ever yet been able to explain fully this beginning of new lives from old. A tiny cell from one plant floats away and meets a tiny egg from another plant : the two join together, and somehow the impulse of that joining together causes the egg to start dividing up in a well-regulated way until the various parts of a new bladder-wrack plant are gradually formed.[1]

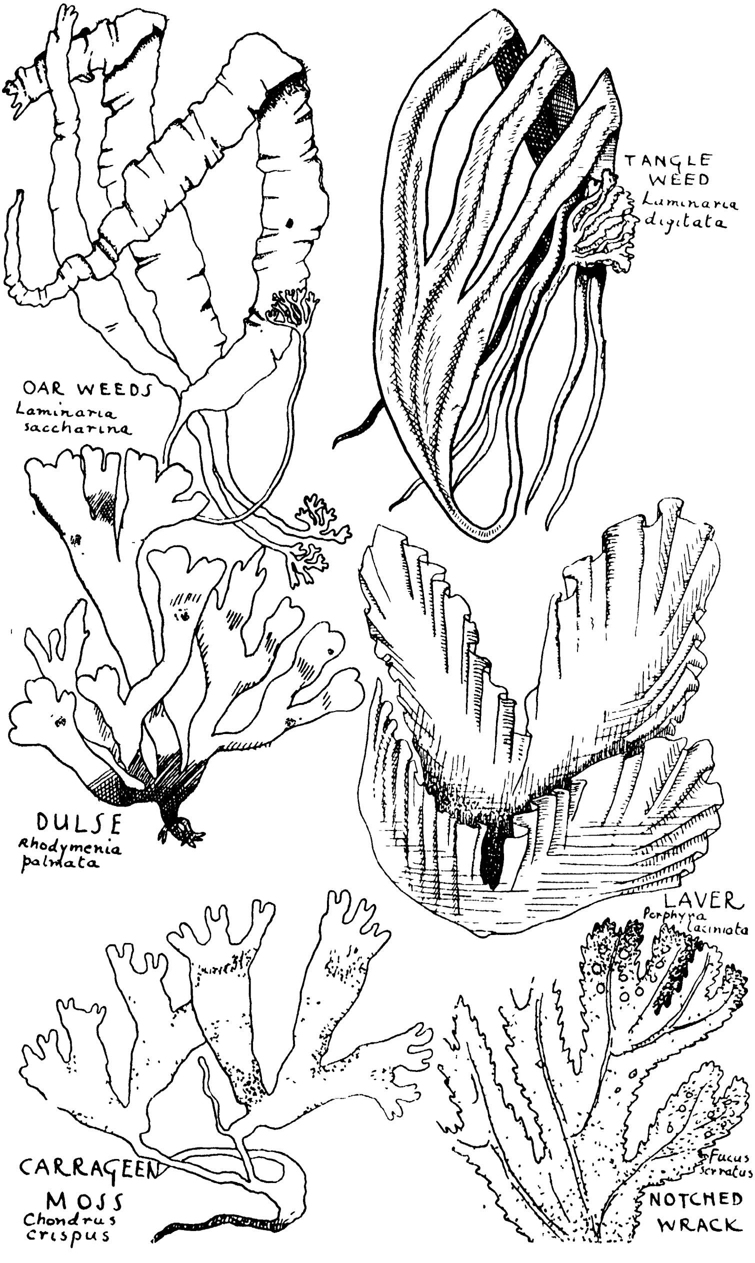
These, then, are the chief ways in which sea-plants differ from land-plants, whose methods of reproduction are described in Chapter III, Book Two.

Here we give a list and some account of the seaweeds one is most likely to encounter on the British coasts.

**Channelled Wrack** (*Pelvetia canaliculata*). This pale yellowish-olive seaweed is usually found at the extreme high-tide mark, near the salt-worts. It has no air balloons, and has very narrow " leaves "—these are quite different from the leaves of land-plants, and are usually called *fronds* —and the edges of these fronds are thicker than the middle and are curled over each side so as to make a " channel " down the centre.

**Tangle-Weed** (*Laminaria digitata*). This weed, which we have mentioned as giving its name to the lowest zone of life on the seashore, is known by its large size ; it has a long cylinder-shaped stem, which opens out into several strap-like fronds. Its " roots " are a small much

[1] For a description of growth, see Chapter III.


TANGLE WEED
Laminaria digitata
OAR WEEDS
Laminaria saccharina
DULSE
Rhodymenia palmata
LAVER
Porphyra laciniata
Fucus serratus
CARRAGEEN MOSS
Chondrus crispus
NOTCHED WRACK

branched bunch of stems with sticky discs. As we have noted, it is among the Laminarians that the greatest number of sea and shore forms live. By tearing up a dozen or so of these weeds carefully and examining them closely it is possible to find more than 100 different kinds of creatures. As many as 66 species of worms have been obtained from half a dozen roots, and those broad fronds are the homes of many clinging creatures. Some of these plants may be found in deep rock-pools higher up the shore.

**Oar-Weed.** (*Laminaria saccharina*). This is another species of Laminaria, and like the tangle-weed it grows to great lengths, often reaching twelve or more feet from " roots " to tip of frond. It may be easily known from the tangle-weed by the fact that only one broad frond grows on each stem : i.e. it is not branched ; and the edges of the frond are crinkled. It lives side by side with the tangle-weed and is of the same brownish-olive colour.

**Notched Wrack** (*Fucus serratus*). The fronds have a thick rib in the middle and their edges cut into teeth, like a saw. Several fronds grow from one stem, and the plant is olive-green in colour. It is found on the lower part of the shore, immediately above the laminarian zone, and also in deep pools. No air bladders.

**Knotted Wrack** (*Fucus nodosus*). This curious seaweed has fronds thinner than the stem, long tube-like fronds that are covered with big air bladders. It is olive-green in colour and is found half way between high- and low-tide marks, especially on boulders.

**Coralline** (*Corallina officinalis*). For many years naturalists could not make up their minds whether this common red seaweed was really a seaweed or not, because it possesses a curious power of sucking up lime from the sea-water and building up a sort of skeleton of lime around itself. When it dies this skeleton often remains behind, in the

exact form of the plant, which is a bushy feathery shape. It is found in pools towards the low-tide mark and cannot live out of the water. In colour deep red or purple.

**Sea Lettuce** (*Ulva lactuca*). In pools above half-tide level this beautiful light-green seaweed gives the appearance of a flower, the fronds forming a cup shape and having deeply-cut-into edges, so that the effect of petals is produced.

**Dulse** (*Rhodymenia palmata*). A common dark-red seaweed, which grows on most parts of the shore, sometimes on the rocks, sometimes on the fronds of larger seaweeds : it is quite a small plant with fronds about two inches long and a quarter of an inch wide. Four or five of these fronds grow from each stem and each frond branches into two or more fronds. The beginnings of new fronds may always be seen at the tips, which have a notch in the middle at the edge, where new fronds will divide off.

**Carrageen Moss** (*Chondrus crispus*). Not in the least like moss to look at, carrageen moss is found on the lower third of the seashore, in pools and sometimes out on the rocks. Has a short stem—one or two inches—and fronds that branch out in pairs, each frond broadening very much to a long wavy outer edge (like long irregular triangles with a curly " base " on top). In colour this plant is dark reddish-brown.

**Purple Laver** (*Porphyra laciniata*). Large purple fronds which are cut in irregular notches and crinkled. Found on many zones of the shore, at low tide coating many rocks and other weeds with a slimy film.

Among the plants on the seashore we may find one or two that are not true seaweeds at all, as, for instance, *Zostera*, called the sea-grass, which often grows in immense quantities between tide-marks in sheltered bays or inlets where the water is shallow and the bottom muddy.

One has to be very careful indeed not to make a fool of

oneself on the seashore ; and many forms of life there have led the scientists a merry dance.

I remember one day, many years ago, a long ancient wooden mast that once belonged to a sailing-vessel was cast up on the sandy beach of a little Cornish village, where I was staying on holiday. This mast was covered on one side with long fleshy wriggling worm-like things a foot or more in length. These creatures were stalked barnacles, brothers of the common barnacles of the rocks.

The stalked barnacle is a shell-fish who cements his head to the bottoms of ships, floating logs, rocks or any other hard object in the sea. From his head this barnacle then grows a tremendous neck, sometimes a foot or more in length, at the end of which dangles his little oval-shaped, shell-covered body.

The body of the stalked barnacle is carefully protected by nine shells, two of which he opens regularly, and out of these two comes a bunch of very fine hairs that sweeps through the water like a trawler's net, catching tiny living food. This network of hairs is called the " glass hand." Because of the stalked barnacle's long neck, he was for some time regarded as a sort of worm. It is now known that he belongs to phylum Arthropoda, family Crustacea, like his little tented cousin of the rocks. To think of the stalked barnacle as a worm is quite as absurd as to imagine that the sea anemone is a flower ; yet what wanderer on the sea-coast has not fallen into that error at one time or another ?

In most sea-pools, and in the little jutting rock-creeks that the sea never quite deserts, you will find at least one or two specimens of sea anemones. In really good pools there are sea anemones dotted about on nearly every angle of rock—anemones red, brown, olive and green, waving their tentacles like the petals of garden flowers.

The sea anemones look so like flowers that they are called *Anthozoa* or *Zoantharia*, both of which names mean " flower animals." The sea anemone, however, is not a plant at all, but an animal.

What look like the " petals " of the anemone are arms, or *tentacles*. They are used to seize hold of objects which the anemone wishes to eat. Though the " flower-animal " has no eyes to see with and no brain to think with, he will never grasp a stone with his tentacles and try to eat it, though if you offer him meat or fish, a shrimp or a worm, he will greedily clutch the feast.

The tentacles are covered with tiny " stinging hairs." These stinging hairs lie curled up all along inside each tentacle. When the tentacles clutch something, the hairs uncoil and shoot out and dig themselves into the victim, anchoring him to the tentacles. And in each hair on each tentacle is a poison which works into the captured creature and soon makes him numb. In this way the anemone can capture creatures much bigger than himself. When the victim is firmly caught, the tentacles bend inward, carrying the food to the big round mouth in the middle of the anemone.

The anemone is the cousin of the jelly-fish—both belong to the phylum *Coelentera*. The " stinging hairs " of the jelly-fish are more poisonous than those of the anemone, but the shrimp or prawn who gets entangled in the tentacles will soon be so numbed by the poison that he can easily be popped by those busy arms into that greedy gaping mouth.

Though he is a very lowly animal indeed, certain species of anemone reveal that they are animals in their method of reproduction. At first you might think there was little difference between the anemone and the bladder-wrack. A sperm leaves the father-anemone and swims out into the wide world of a rock-pool or the open sea ; but instead of meeting an ovum out there he swims about until he comes to a mother-anemone, into whose mouth he swims, and deep down in her body he finds the sacs where the ova are growing. There the sperm joins with an ovum, and soon forms a new young anemone inside the body of the mother.

Young anemones live and grow inside the body of their mother for a time, sharing her food, and when they have

grown tentacles they swim through their mother's mouth, and walk away on their tentacles over the rocks until each finds a place on which he can settle down.

Some of the sea anemones do not bring forth their young in the way we have described. In certain species there are no sperms and no ova, no meeting of sperm and ovum to form a new anemone. The anemone brings new anemones into the world by simply splitting in half. The two halves heal up and grow into two new anemones.

This is such a very interesting thing that we must stop and look at it rather closely. Those readers who want to get on to more descriptions of the seashore creatures had better skip the next chapter to our accounts of the prawns and fish and worms and birds that follow ; but I should advise them to return to Chapter III before they have done ; for in this next chapter we are going to open up living things and see how they work : a rather important matter if we are to understand much about them.

# CHAPTER III

# FROM AMOEBA TO MAN

It is said that in the beginning the first creatures upon earth were just simple cells of life. In the seas and ponds and rivers to-day there are millions upon millions of such simple cells of life. They are of many kinds, two of the most common sorts being the cell-animals called *amoebae*, and the cell-plants called *diatoms*.

The amoeba is so small he can be seen only through a microscope. He is a blob who is always changing his shape. Yet he is a living animal as truly as is the elephant; and for a moment let us glance at the wonders of his life.[1]

The amoeba eats, though he has no mouth. His flesh is a sort of muddy blob that oozes about. He eats the minute cell-plants called diatoms by simply oozing round them and absorbing what is good in them. Like certain sea anemones, the amoeba reproduces his kind by splitting into two halves, which grow into two amoebae : this is probably the earliest way of reproduction in the history of life upon the earth.

Do not imagine that these minute one-celled creatures, who can only be seen through a microscope, are as blank as bubbles. They have parts, like more highly developed animals. They have their own way of moving about in search of diatoms.

To look at, the amoeba is a blob of greyish watery protoplasm, with one or two spots. One of these spots is called the nucleus. This is a darker, thicker part of the blob. This nucleus always splits in half when two young

[1] For an account of diatoms see Book Two, Chapter I.

amoebae are formed, half of the nucleus going to each of the two new amoebae. If you cut off a part of an amoeba which does not contain half the nucleus, that part very soon dies.

From this it would seem that the nucleus is the heart and brain of an amoeba, without which he cannot live. But we cannot think of the " heart " and " brain " of an amoeba in a literal sense, for he has no heart or brain, as we shall see in a minute or two, when we come to glance at those organs.

An amoeba moves much as a pool of water moves. If you pour several buckets of water on to a spot in an uneven back yard, the pool of water will spread by running out arms and gullies in all directions. The amoeba moves by running out jets all in one direction and flowing to where those jets are, leaving one place for another like a pool of water slowly draining off downhill. The jets of amoeba are called " false feet " (*pseudo-podia*).

Amoeba eats by flowing round his food by means of his " false feet " ; and other of the dark spots in his body may be bits of diatom digesting—that white spot over there is a speck of water he has drunk. Those parts of his food and drink which he cannot digest or absorb he will either leave behind by flowing on, or squeeze out of himself by a pushing movement.

Our tiny amoeba is very much alive ! He is one but of many thousands of species of one-celled creatures in the phylum *Protozoa* (" first creatures"). Most of these creatures " live in the sea, in rivers, streams, lakes or ponds ; some grow on damp soil while many live in the bodies of larger animals. Some move about by pseudopodia," others send out a single jet that waves to and fro, like a paddle, to drive them along. Others again move by rowing themselves along " by a number of short hair-like threads known as cilia. Some protect themselves with an outer coat or skeleton of silica, which is fashioned into most elaborate and beautiful shapes ; others construct a similar armour of limestone. No matter what their shape may be or what form their activities

may take, their mode of living—their feeding, breathing and reproduction—is fundamentally the same as that of amoeba. Since it is from these simple animals, or something akin to them, that the rest of the Animal Kingdom is presumed to have evolved, they are called the Protozoa—literally, the first animals—and we speak of the Protozoa as a phylum, or branch, of the Animal Kingdom."[1]

We have said that amoebae can be seen only through a microscope. There are actually thousands of kinds of one-celled creatures far too small for that. It is doubtful if some of them will ever be seen individually, though great masses of them, like swarms of bees, can be detected, and often they can be traced and known by the work they do. It is said that some of them are so small that 200 of them would not cover a pin's head.

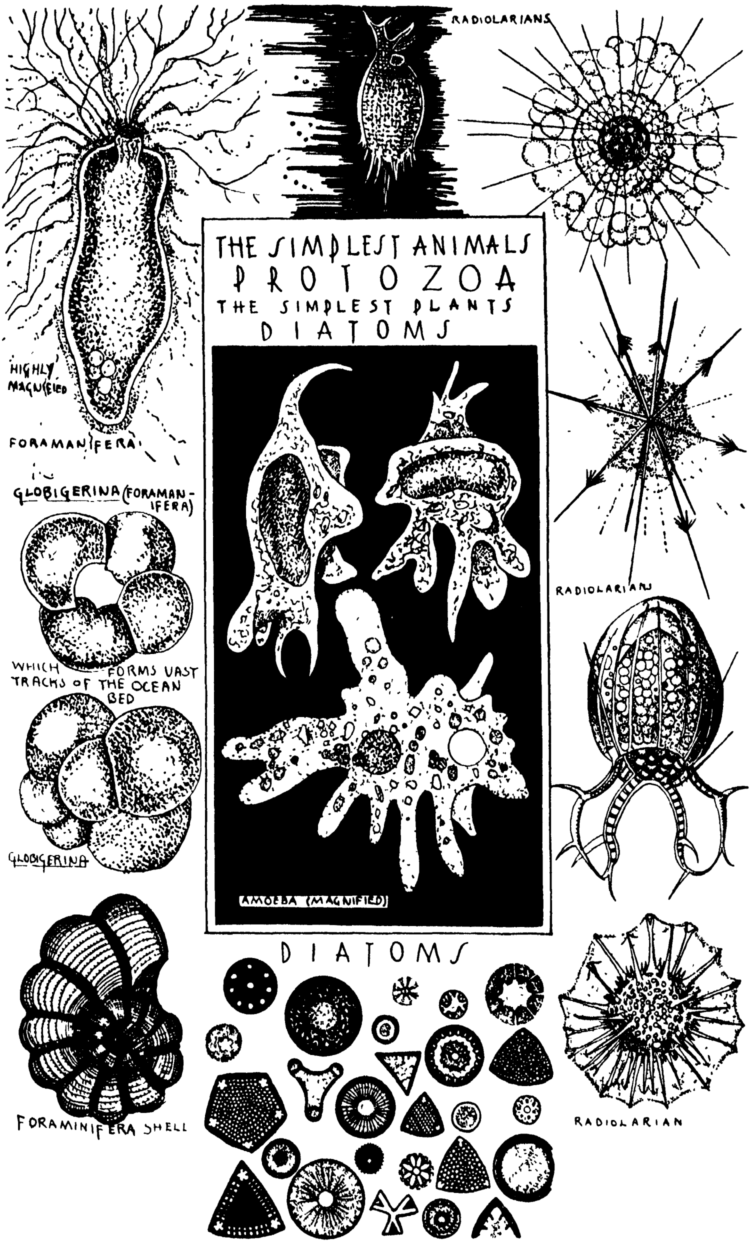
Some of these creatures are not at all like amoebae. Those called *radiolaria*, for example, are of wonderful geometrical designs and of exquisite beauty. No Eastern potentate's jewelled crown, no Taj Mahal, no dream-palace from the hand of an artist, could approach in fairy-like glory the glass-like wonders of some of these creatures : in our illustration called Phylum Protozoa we try to give you some faint idea of the marvel of these tiny living beauties.

The glass-like skeletons of these radiolaria are made of silicon, which is a compound made from the elements of silica and oxygen. There are great amounts of silica and oxygen in the sea. The sea contains many sorts of substances floating about " in solution "—that is, chemically changed from solid into liquid state. A thousand pounds of sea-water, indeed, contains, on an average, 35 pounds of solid matter dissolved in it.[2]

The living creatures of the sea eat and drink a great deal of this dead matter with their food ; and the busy cells of

[1] *The Standard Natural History* (ed. by W. P. Pyecraft), p. 8.

[2] Twenty-seven pounds of this would be common salt, a fact of which we are made aware when swimming, if we inadvertently gulp a mouthful of sea !


RADIOLARIANS
THE SIMPLEST ANIMALS
PROTOZOA
THE SIMPLEST PLANTS
DIATOMS
HIGHLY MAGNIFIED
FORAMANIFERA
GLOBIGERINA (FORAMANIFERA)
WHICH FORMS VAST TRACKS OF THE OCEAN BED
GLOBIGERINA
AMOEBA (MAGNIFIED)
RADIOLARIANS
DIATOMS
FORAMINIFERA SHELL
RADIOLARIAN

their bodies (which we shall glance at in a moment) turn some of this dissolved stuff into solid form in most wonderful and useful ways. Thus are made the shells of the shellfish, the bones of the fish that have skeletons, all the hard dead parts that make an armour or a stiff structure to hold the life of the creature together.

Many of the one-celled creatures make shells. The most interesting and important are the creatures called *foraminifera*. Foraminifera make shells from the lime in the sea, shells often of marvellous beauty. The foraminifera are as grains of fine dust in size. Four million of them would not weigh an ounce.

The sand of the beach is made up very largely of the shells of foraminifera. These shells are so small that a single ounce of sand may yield one and a half million of them. The foraminifera feed themselves through tiny holes in their shells, holes through which they stick hairs that wave about and catch and draw into the shells particles of diatom or amoeba or other food which the foraminifera eat. (The word " foraminifera " means " hole-carriers.")

Now, if you want to get a good idea of the age of the earth, of the years that have unfolded, season by season, in their hundreds, in their thousands, during the history of living things, I can think of few better ways than of thinking about foraminifera.

If you want to get a vivid, stirring picture into your mind of the way in which the earth formed into high mountains and deep seas, by crumpling and crushing, by heaving and rolling, hills and valleys being made during unthinkable ages in the past—again, I do not know what you can do better than to think of the ways of the tiny one-celled foraminifera.

Because all the chalk in the world is made of the shells of foraminifera ; the high white cliffs of England, the rolling downs of Sussex, miles of the land in Kansas, Arkansas, Texas and in many other parts of the world, are made of chalk—that is, of the shells of foraminifera, packed and pressed together, in which state they form chalk.

What uncountable numbers of lives of foraminifera have gone to the building up of shelves of land scores of miles long and wide, and hundreds of feet thick ! The city of London is built upon a great cup of chalk, a huge bowl made from the shells of foraminifera which lived and built their houses there when southern England was under the sea.

The shells of one species of foraminifera made all the limestone in the world : the stone of which the pyramids of Egypt were built is the hardened shells of foraminifera, and the very peaks of the Alps of Switzerland that pierce the skies in the heart of Europe are the shells of foraminifera which once coated their tiny soft bodies from the lime in the sea in which they lived.

Thus we see at a glance what unimaginable ages have passed for the shells of foraminifera to have formed into Beachy Head and Flamborough, into the stones of the Pyramids, the rocks of the Alps and the rich ground of other vast areas of the world ; and we see, too, through what convulsions the earth must have passed for these cliffs and mountains and desert monuments to stand proudly above the sea, when in the beginning they were formed by the shells of foraminifera falling in millions to the bottom of the sea and piling up there. To-day the shells of foraminifera form one-third of the bed of the Atlantic Ocean.

Yet it would seem that during this vast time one-celled creatures not unlike foraminifera and amoebae have built up finer structures than Beachy Head and Texas, finer structures than the Pyramids and the Alps ; for chalk and limestone are *dead* stuffs that have been used and left by living things ; and in the ages past, during the dawning of the world, the one-celled creatures learned to build up *living* structures that grew into the fish of the sea and the fowl of the air, into the insects and plants and animals, and into man himself.

When certain kinds of one-celled creatures divided and grew in numbers, they did not make for themselves tiny rabbit-warren shells, and swim away and live each one the life of a hermit in his shell. Instead, they clung together and

learned to work together and to aid each other in the functions of life. Sometimes they clung together and made spongy masses that evolved in course of time into the true sponges.[1] Sometimes they learned to aid each other in pushing through the water, wriggling in a line like worms : and these creatures became the first simple worms—the first creatures on earth to have two sides, and a head and tail.

Now, these creatures began to reproduce their kind by the sperm and egg method which we watched in the case of the bladder-wrack ; and we might well ask : Why did they begin to have children by this strange and round-about way ? It was the opposite way from that in which the amoeba reproduced his kind ; for, instead of one cell dividing into two, two cells joined up and became one before dividing and growing into a new being. This was a much more mysterious thing, and you would think the older way was easier.

It would certainly have been easier in the beginning, but it would not have been better ; and one reason for the new way was this : when simple creatures split in half and become two new creatures the two new creatures are so like their parents in every way that you can hardly tell the difference ; but when a new creature is made from *two* parents, it cannot be quite like either parent : it may be bigger or smaller, stronger or weaker, than either of them. This became a most important thing, perhaps the most important thing in the history of life.

Because : if the world in which we live always remained the same, the creatures living in it could always remain the same also : it would not matter then if children were always just like their parents. But the earth is always undergoing changes : it may get hotter or colder, wetter or drier, and unless the creatures change also they may be killed by the earth-changes.

Suppose our seaweed, the bladder-wrack, is living in the North Sea, and the climate begins to get colder, as it

[1] For sponges, and for an account of some sea creatures who dwell together in one mass, see Chapter VI.

did during the great Ice Ages. If the seaweed could not change its character and *adapt* itself to the colder conditions, it would speedily die off the face of the earth. But suppose, because each seaweed has two parents, that some seaweeds are stronger than their parents and can withstand the cold better than either of their parents ; then they could go on living in colder water, and the species called bladder-wrack would stand a chance of surviving.

So it is that as long as children are different from their parents, species can change and adapt themselves to a changing world. You can see that this was one very good reason for the egg-and-sperm method of carrying on the life of creatures. And once this new and better way was begun, of certain cells becoming sperms and eggs and doing the job of making new children who varied from their parents, it became more and more difficult for creatures to slip back into the old splitting-up way of reproducing their kind.

In this way, therefore, various living creatures came to develop along different lines to suit the conditions of the earth about them. In those early seas some of the first wriggling worm-like creatures got in the habit of moving themselves always in one direction—and the part that went first was the first part to reach food, the first part to face danger ; and so the cells in the front began to take charge of eating and fighting, and even in choosing in which direction the whole lot of them should swim. This was the beginning of a head : the cells in front forming, after ages of time, mouth, eyes, brain.

Scientists call living things *organic* because living things can organise to help themselves. That is to say, living things can " pull together," make use of natural laws which aid them, and overcome natural laws which threaten them. In foraminifera we see some of the smallest living things using the dead stuff in the sea to make hard coats of armour (shells) for themselves. It is not, therefore, perhaps too hard for us to imagine them dividing and multiplying to build up the bodies of creatures, and using the dead stuff

in earth and sea to make bones and flesh. For this is the secret of growth. When you grow, millions of cells within you are breaking in two and the two halves are growing into two new cells, in precisely the same way as the amoebae divide and multiply.

You are made of millions of cells of many different kinds. The cells of your body grew into different kinds by grouping themselves into armies, each army to work at a different task. Each army of cells of one kind is called an *organ* ; and it was by working at their different tasks that the cells became different, each army losing all power of doing anything but the special task which it set itself.

Let us get this clear. We can hardly understand the activities of the cells in a body if the word " cell " is a mere name to us. What is a cell made of? We have said that the amoeba is a " blob of greyish watery protoplasm." What is this protoplasm? Can we tell what it is by watching an amoeba under the microscope? Watching an amoeba under the microscope is like watching life in one of its earliest forms. Certainly it is like watching life in its most naked and visible form. What is this life that stirs the lowly amoeba to press out his " false feet " and engulf a diatom?

Long ago Heraclitus likened life to a fire. A fire needs three things:

(1) Stuff to burn (fuel).
(2) A current of air (draught).
(3) Raking out of the ashes.

Food is the fuel of life, breathing is like the draught of air fanning the flames of life, and getting rid of the waste matter after burning is like raking out the ashes so that the fire is not clogged up and put out.

The fire of life is perhaps not unlike the furnace of a locomotive or a power plant; for the heat is turned into *energy*, into pressure for movement, and that again is directed to some purpose, as when a locomotive runs from New York to Chicago or a power plant supplies electric current to light up a city.

If you could imagine a locomotive in which the coal used in the furnace was not all burned up and turned into energy, but some of it went to repair the wheels and pistons, the boiler, the steam pipes and every other part of the engine, you would have a nearly complete picture of a living creature. Of course such a locomotive would *work itself*, without driver or stoker. Since there is no steam-engine so wonderful as that, we are not right in calling a living body a machine.

Let us look a little more closely at how the fire of life is fed, at how this self-fuelling, self-repairing, self-directing "engine," which is the body of a living creature, works. We have said that the bodies of living beings are made of *protoplasm* (a word which means "the first stuff"). Protoplasm is made out of some of the elements and compounds from which all things in our universe are made.

For instance :

An average-sized human being has in the body about 12 gallons of water.

Enough oxygen in solid form to make 9,000 gallons of gas.

Enough carbon to make 12,000 lead pencils.

Enough phosphorus for 10,000 boxes of matches.

Enough hydrogen to enable a balloon to fly over the Alps.

Enough iron to make a packet of tin-tacks.

Salt enough to fill fifty or sixty salt-cellars.

Seven pounds of nitrogen.

Small amounts—"traces," the scientists say—of calcium, magnesium, sodium, potassium, sulphur and other things.

Now, all these elements and compounds are not arranged in groups in different parts of our living bodies : they are spread all over us, and every cell of us, every blob of protoplasm in us, has every one of these things, though not in equal quantities.

The tiny amoeba himself has every one of these things in

him ; and the marvel is that in living matter all these elements and compounds are being used like the thousands of workers in one of Mr. Ford's factories. Indeed, they are used in a more wonderful way than that ; for in their movements and their work within the cell of life they form substances so rich and strange no man can say exactly what they are.

Scientists lose sight of those elements which make protoplasm ; and when those elements return from the living protoplasm they are dead, and so they cannot reveal their adventures. It is only when a body dies that scientists can look at it closely, can take it to pieces and explore it. Then, however, it is too late to begin to understand what it was like when it was alive.

Scientists have shown amazing cleverness at finding out facts about things that are dead. They have found that in all the world there are but 92 elements—an element being a thing not made from other things ; *a foundation-thing.* They have found that out of these elements all things are made, both living things and dead things—stones and starfish, rocks and men : the sands, the seas, the seaweed, the living creatures of the " dry land " and the deep, the dead things like the atmosphere-gases. Most things known to us in the universe are compounds—that is, things produced by the joining up of two or more elements that are thereby changed into the thousand-and-one dead and living things.

The scientists have broken up the elements into their smallest possible pieces ; and in doing so they have found a great wonder. They have found that the elements from which every solid thing is built are NOT SOLID !

The smallest pieces of the elements are called atoms. When we cut things down to atoms our imagination faints and fades away.

For a man is as big beside an atom as the sun in heaven is big beside a man. And an atom is a field of electricity, a field in space in which certain impulses of electric force play with one another, like footballers on a football field ;

though the impulses within the atom are quite unknown to scientists, who have never yet been able to see them and learn what they are. We know about the electrical impulses in the atoms only by having seen what they do.

The atom is a field of electricity so small " that a million million of them side by side would extend only over a fraction of an inch, and so light that a million million million of them would not weigh so much as a grain of dust."[1]

It does not take anything like a million of these atoms, however, to make up a small quantity of a dead compound —the smallest possible grain of sand, say, or drop of water. The smallest possible piece of a compound is called a *molecule.* Molecules of dead compounds often consist of about ten or twenty atoms, joined and chemically changed into the compound. In some compounds only two or three atoms are needed to make a molecule of a compound. It is a big molecule that contains more than thirty atoms. Even so, such small pieces would be quite invisible to the most powerful microscope.

When we come to living things we find a very different state of affairs. A molecule of living protoplasm would be quite invisible to any microscope ; but it would contain something like 400 billion atoms !

Can you wonder that scientists have made as yet very little headway at understanding living protoplasm ?

The humble one-celled amoeba, one of the smallest of living animals, is made of countless billions of molecules ; and each of those molecules is built up of about 400 billion atoms.

That's enough to stagger us ; and it's a fact worth looking at quietly for a moment or two before going on with this book. . . .

Now what do these marvellous molecules of protoplasm do ? (It's always easier to find out what things do than it is to find out what they are.)

The molecules of living protoplasm form such things as fats, carbohydrates, and proteids ; things that I shall not

[1] E. N. da C. Andrade, *The Mechanism of Nature.*

attempt to describe for you. Enough if we know that they are the substance of your flesh and blood. We may begin to glimpse one aspect of the nature of these things if we understand that every species of creature (each of the 60,000 species in phylum *Mollusca*, for example) has a different kind of fat in its flesh, a different kind of proteid.

We may be able to imagine all these marvels better if we watch the living body at work.

It has struck many people as being curious that when they eat fish (or anything else) the fish-flesh turns magically into human flesh inside them. There is really nothing magic about it. The real part of eating is digestion, and to understand digestion we need but remember that we always eat *food* which has been alive. We eat meat and fruit and vegetables, seed-foods like the corn in our bread and biscuits, root-foods like potatoes and carrots. All these are living things. We cannot eat dead things, like stones and rock. When you eat meat, you may think you are eating what is dead, because the life of the cattle or sheep has been taken by the slaughterer ; but life still lingers in the meat.

We eat living stuff because the cells of our bodies need stuff *as like themselves as possible* because they have got to *change the food into their own likeness.*

When food comes in, millions of busy living cells in our body—each cell built of billions of molecules, each molecule 400 billion atoms !—millions of busy cells in our body have to unpack it and take it to pieces. That is to say, they have to begin to break up the wonderful living molecules of the food, which make it unlike themselves. When they have broken them up enough, they build them up again to become new molecules like themselves.

When these new molecules are ready they are new parts of the living body, with new strength and energy for carrying on the life of the creature. In other words, your food becomes new parts of you.

New molecules of protoplasm are needed by every living body, by your body and mine, by the body of the ape and the eagle. Every day, every hour, every moment, we need

new molecules of life, because the molecules of which we are made *wear out.*

Day by day, hour by hour, moment by moment, the molecules of our living protoplasm *wear out.* Our movements use them up ; and they must be renewed. That is why we eat ; and digestion is simply the taking to pieces of living molecules *unlike* our own living molecules (though as like as possible) and building them up afresh into new, young, strong molecules of our own to enable us to carry on with living.

If there be anything more wonderful than the fact that every kind of creature on earth has its own specially different fat and proteid it is that these differences can be changed by the work of living cells, who can make new molecules out of old in this strange way in our bodies when we eat.

We have seen that the cells of a body grow into different kinds by grouping themselves into armies, scientifically called *organs* ; and to complete our peep inside the bodies of living creatures we must glance at those organs and their relationship to one another.

Certain cells group themselves into an army for the special task of moving us about : they become *muscle cells.* Other cells group themselves for the job of swallowing and digesting food : the cells of the jaws, mouth and digestive organs. Still further cells group themselves into armies (organs) for the purposes of breathing : they become lungs or gills. (Lungs and gills are exactly the same sort of thing, only gills are adapted to strain oxygen out of the water and lungs to strain it out of the atmosphere.)

Now, you can see that the muscle cells want food and air just as much as do the digestive cells and the lung cells : they have lost the power of getting food and air for themselves, so other cells must do it for them. That is where *organisation* comes in. In most animals there is a wonderful blood system, which is simply a way of sending food and oxygen (the fuel and the air for the fire of life) to every part of the body.

Blood is composed of myriads of tiny cells floating in a sea-watery mixture called the serum. The red cells of the blood, called corpuscles, are nothing but disc-like one-celled bodies which carry food and oxygen all over the body, even to the furthest parts.

Every organ of the body is linked up with every other organ by several systems like the blood system. There are the nerve cells of the nerve system, for example. If we liken the cells of the blood system to tramp steamers carrying food and air to every part of the body, we may liken the nerve cells of the nervous system to ocean cables or wireless waves sending *impulses*, swift as light (in this case, "swift as thought"), to every part of the body.

These marvellous systems of cells have organs that direct them. The blood cells are impelled by the heart. The nerve cells are directed by the cells of the brain—the brain, that unimaginable organ that rules so much of the body like a government that really rules a glorious civilisation.

In using the word "glorious" we are not trying to put a false beauty upon the living body of an animal ; but if we would understand the life of any creature in the world of nature, we must send our imagination out to try to grasp the glory of *organisation* ; for it is by grouping in just this way that the tiny, helpless, blind, defenceless blob of watery life called amoeba has built up the bodies of fish and reptiles, birds and insects and men : millions of single cells grouped in special armies and bound together by living systems of communication : that is a creature—that is what you are, and what a bird is !

This book is not about anatomy[1] or physiology,[2] otherwise we would go on now to explore the organs and systems of creatures. But in order to get a rather clearer picture of the living body let us look briefly at one system. We have glanced at eating—at the fuel for the fire of life entering the body, and being broken up, and put together again in

[1] The science of the parts of living bodies and how they are made.

[2] The science of how the parts of living bodies work together in the whole life.

the likeness of the body. Let us now glance at breathing, at the draught of air blowing upon the fire of our life.

When we come to pages 130-131 we shall see what a number of gases go to make up the air we breathe. One of those gases, *oxygen*, is the air needed to enable the fire of life to burn. We breathe the air into our lungs. Lungs have millions of microscopically small folds in their sides. These folds form pouches, and the walls of these pouches are so thin that gases can pass into and out of the lungs across them. Outside the lung pouches, millions of red blood corpuscles are continually streaming by ; and the oxygen passes across to them and fills them, and off they flow through the arteries, out through the veins to every part of the body. As they flow, the cells of every kind which they pass obtain a supply of oxygen from them in the same way as they obtained oxygen from the lungs.

Now, what happens to the oxygen in the cells ? Why, it supplies energy to the cells, as a strong draught of air supplies energy to a fire. This happens because the living cells contain sugar, and when oxygen enters the cells the sugar burns up, and gives out energy in the same way that coal gives out energy when burnt on a fire. A coal fire is used to drive a steam-engine : the sugar fire in each living cell is used to drive a living body. This little burst of energy in every cell creates the energy of life, and the oxygen combines with the carbon in the sugar to form the gas we call *carbon dioxide*. Carbon dioxide is of no use to cells of life and it filters out again into the red blood cells, who carry it back by way of the veins to the lungs once more, where it passes through the pouch walls and is breathed out by us with the other useless gases into the atmosphere.

This very wonderful system of energy-distribution is but one of many marvellous organisations in our body. The blood stream itself is used for another circulation of necessaries—food : the fuel for the fire of life ; which is carried in the form of juice by the blood corpuscles to every part of the body.

Having now peeped inside living bodies, let us take

ourselves out of the laboratory back to the beach, which is the cradle of life. We should now be able to understand far more clearly certain very remarkable things about the shore-beasts. Can we, by clambering up to rock-pools, and digging down through the sand, discover in any way *how* creatures so varied have grown through vast ages from single-celled forms ? We shall not, of course, be able to find the impulse of life which has baffled the scientists ; but keeping such a quest in mind is the only way of understanding certain features of shore life.

# CHAPTER IV

# CREATURES THAT SWIM AND CREATURES THAT CRAWL

THE OTHER DAY a French scientist carried out some interesting experiments. He put lumps of more or less soft stuff, a kind of putty or plasticine, into water, and drew them along under the water at different speeds. The pressure of the water, as they were drawn along, changed the shapes of these lumps : they became thin at the front and at the back, and they bulged in the middle, like cigars and submarines and airships—in fact, like fishes !

These lumps wobbled about when being drawn along, and rolled round when left still ; and the scientist stuck into them keels to keep them steady. Then, indeed, they began to look like fishes ; because the fins of fishes are only keels and balancers for keeping the creatures from wobbling and rolling as they swim along under the sea.

This experiment aids us to see how fishes evolved into their ordinary cigar-shape. So soon as the little living worms could push themselves at will through the water, the pressure of the water began to mould them into the cigar and airship shape. They began to wobble—dangerously ; and so cells within the creatures took up the special task of building keels and balancers, which we call fins.

The only true fish in the sea are those that are more or less airship-shaped, and have fins to steady them : they breathe through gills, and most of them, but not all, have scales on their skins. We shall look more closely at what scales are when we come to view the adventurous lives of the

salmon and the eel.[1] Let us first consider the fins and bones of true fish.

So steadily and so perfectly do many fish now swim in the sea that some of them can reach the speed of express trains. The fastest-swimming fish of all is the mackerel, who can travel at sixty miles an hour. This is quicker even than the speed of the deep-sea sharks, who can shoot through the seas at a terrifying rate.

You can see that without *fins* not only could no such speeds be attained, but steady swimming of any sort would be impossible. Yet look at a rock-fish in a sea-pool. He is a bright-coloured fish, mottled and marbled with crimson, orange, and pearly white. His proper name is the *wrasse.* See how he can dart from a crevice in the rock to hunt a little prawn ! The rock-fish's fins act as guides and rudders in the twists and turns he wishes to take : the back fin (called the *caudal* fin) is not the only rudder : the fins on the back also (called the *dorsal* fins) and those in the sides (*pectoral* fins) and those underneath (*ventral* and *anal* fins) all help to guide the rock-fish to the exact spot he wishes to reach.

*Snap !* He has missed the prawn, who, with an acrobatic leap, has scuttled to the other side of the pool. But look over there at those sea anemones ! There's a blenny in among them, tugging for all he is worth. He tugs like a puppy pulling at some bed-clothes : the blenny digs his jaws in among the tentacles and jerks and tugs—and we wonder why. Blennies do not eat anemones.

With a big tug the little fish hauls a complete prawn out of the inside of the anemone. Probably the prawn is paralysed by the poison in the tentacles of the anemone. The blenny shoots away like an arrow, with the prawn in his jaws like a game bird in the jaws of a retriever dog. And the anemone shrinks up in a sad and faded fashion, doubtless feeling a bit hollow inside.

The blenny would never have the strength to tug so hard and so successfully if he had not an elaborate frame-work

[1] See Chapter VII.

of bones. Like the steel skeleton of a house, the bone skeleton of a fish holds the creature together; and the most important bone of all is the backbone. You may break a rib and still carry on, even if there's an ache in your side ; but break your backbone, and you are not able to move, and are in serious danger of losing your life. Like the head-stone of an archway, the backbone of a creature is the centre, and the hold-fast, for all the other parts.

We can see how the little swimming worms first grew a backbone if we are lucky enough to come across that curious little creature called the lancelet. He is the simplest, and perhaps the earliest, of all kinds of fishes. He is three or four inches in length. His backbone is a thin single wiry piece of bone that runs from head to tail and keeps him together. He has no other bone. He has no skull, like a fish ; although where ribs might be his flesh is thickened into ridges as if they were the beginning of ribs. He has no proper fins ; but where dorsal and anal fins would be, his skin folds over and forms flaps, which might be the beginning of fins. He has no eyes ; but several spots on top of his backbone are sensitive to light, and may be the beginning of eyes. Like the anemone, he has no brain ; but he is enough like a fish for some scientists to have called him " the prophecy of a fish." He is a form of life which seems to have stopped short between being a worm and a fish.

By turning to look at our little grey spotted blenny in the pool here, we can gauge roughly how far advanced are the true fish from the rough forms with which they started. *Blop !* There's one blenny has leaped right out of the water on to the rock ; and instead of flapping helplessly he clambers along the seaweed, using his pectoral fins almost as the seals use their flippers.

In different fishes the fins are altered (*adapted*) for different purposes ; the little gobies in our sea-pool, for instance, have their ventral fins formed into discs which enable them to stick on to the rocks when the sea is rough, in just such a manner as the limpets cling. The pectoral fins of the flying fish are extended and adapted into true wings, so

that this fish can fly for considerable distances over the sea.

The gobies in our rock pool are hardly to be distinguished from the blennies, save for their smaller size. They are an inch or two shorter. In nothing are the blennies, gobies and rock-fish so marked off from the lancelet as in their *backbones*. True backbones are made up of scores of little bones all locked together, like a firm chain. All creatures having such backbones are called *vertebrate* animals (from the Latin word *vertebra*, a joint). Animals without backbones are called *invertebrate*.

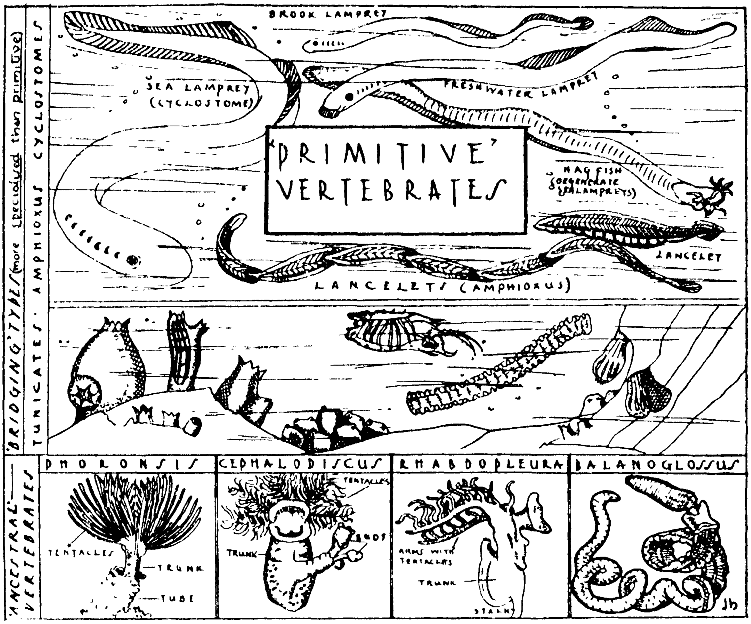
The advantage of a jointed backbone over a thin rod of bone is that a closely jointed chain is not so easily snapped when bending. The vertebrate backbone, in short, is *stronger* and more *pliable*. It is also a better sort of bone to hang a skeleton upon, for ribs and other bones will fix into the joints more readily and securely. From the first thin rod of bone, called the *notochord*, the true backbone has been evolved ; and scientists now group all true backboned creatures into the phylum *Chordata*.

This sort of improvement in the building of living bodies is one of the clues we possess to the grand chain of evolution, whereby creatures have climbed from the single-celled state.

Many creatures have stayed at a lowly form and way of life, like the amoeba and the lancelet. Some have even gone back, so to speak, like the parasites, the tiny enemies of man, a few of which we shall have to look at later on in this book. But the miracle is that some have gone forward to a marvellous perfection. Among true fishes there are two classes which show stages in the evolution of bones. The class called *Selachii* have rather soft elastic bones, made of cartilage. Sharks, rays and dogfish belong to this class. In the other class, the class of the true *bony fishes*, the cartilage hardens into proper bone.[1]

One reason for the change and growth of the forms of life, one reason for improvements in body-structure throughout the ages, is revealed in the French professor's experiment

[1] See illustration on p. 61.




with soft lumps of putty in the water. That explains, not only the shape of fish, but also the growth and placing of fins. In like manner the forces of nature, acting upon the living cells, have moulded all created forms ; at least, these forces have done about half the work, the other half having been done by the creatures themselves. As we have already seen, living creatures have adapted themselves to their environment. They have overcome natural laws which threaten them and have used natural laws which aid them.

Before we leave the blennies in our sea-pool let us look in some fashion at the way in which they live. We have seen that their ventral fins have become adapted into discs to enable them to cling to the rocks when the sea is rough. They use these suckers at one very important time of their lives—when they are guarding their eggs.

Everybody knows that most fish are *oviparous* creatures—

that is, creatures whose young come forth in eggs, like birds, and remain in these eggs until they are strong enough to break through the shell or other egg-covering. Most people know, too, that among fish-mothers are the world's champion layers of eggs. Mother fishes as a rule produce many thousands of eggs, sometimes hundreds of thousands, in a few cases millions. The cod lays over nine million eggs. The plaice, or " flat fish," lays a million. It has been estimated that a mother eel lays between ten and twenty million eggs : if all these eggs became full-sized eels, they would, if placed end to end, stretch half round the world. If the children of fifty eels all grew up, they could make a chain to the moon and back again. But they don't all grow up : instead of growing up, they provide food for millions of other small creatures in the surface-waters of the seas.

If fish made good parents, they might produce but a dozen or two of eggs and guard those eggs and the little fish that hatch out of them (generally called " the fry ") with their lives ; but fishes are, on the whole, the most neglectful parents upon earth, and generally leave their armies of eggs to float about uncared for in the vasty deep. Most of those millions of eggs and young fish are gobbled up by larger fish and sea birds, and but a few survive to grow up to full fish-hood.

Yet some fish are exceptions to this rule, and make good parents. We shall watch the salmon making a nest for the young in Chapter VII, and in that same chapter we shall see the domestic tragedy of the eel ; but we need not wander away from our sea-pool among the rocks in order to find good parents among the fishes.

Our little five-or-six-inch-long blennies make excellent parents. The blennies take pains to fix their eggs into the inside of empty shells, or the under-sides of stones or ledges. They stick the eggs in these safe places by means of a gummy stuff that forms inside them and which they squeeze out of themselves around the precious eggs, where it forms a miniature sea-wall. The blennies often guard these nests at risk to their own lives. They will fight intruders, and will

cling by their ventral fins beside the nest though the storm-breakers swirl and dash them.

In our pool we can actually observe the best parents in the fish world. There in the pool we can see a small stickleback, about six inches in length, graceful and slender, olive-green above, white beneath. Along his back he has fifteen sharp spines, which he keeps folded down in a sheath while he is at peace with his neighbours, but which he can erect into a terrible weapon when things go unpleasantly. The stickleback is a relative of the fresh-water " tiddler " of the city parks, that few children have not fished for with a length of string and a bent pin ; but the fresh-water stickleback has only three spines in his back instead of fifteen. Some species of stickleback have forty spines.

Now, father stickleback is perhaps the best parent in the fish world. In spring, father stickleback assumes the task of nest-building. Collecting the weed debris and any loose stuff he can find, he makes, with the aid of a sort of natural glue which forms in him, a sugar-loaf-shaped nest, open at one end, smooth inside, like a bird's nest. This task takes many days, and the stickleback has to defend the nest against many fierce rivals.

While he is working thus, he is growing grander in appearance. His breast becomes scarlet, his back olive-green, his spines shiny and sharp. If these gay colours fail to attract a mate for him, he may use his spines to give a female stickleback a nasty prod, or he may even nip her with his sharp teeth.

When the eggs are laid in the nest, the mother stickleback will have no more to do with home life, and escapes as soon as she can. Father is left in charge. For long spells he fans the water with his spines at the entrance to the nest. This keeps a stream of fresh water flowing over the eggs and over the young when hatched. Until the baby sticklebacks are able to look after themselves, the father defends them and cares for them ; but they soon scatter, and father's life work is done.

When newly hatched, the stickleback is a very beautiful

little creature. He feeds at first on amoebae, diatoms and such small forms of life. Soon he needs something more substantial—worms and insects, prawns and shrimps; and he is off on the adventures and explorations of his life.

We have already noticed the prawn as a dainty dish for sea anemones and blennies; and it is time we paid him the respect which is his due. There are numbers of prawns wandering warily about our rock-pool, though it is difficult to see them because they are almost transparent, like animated bits of cut glass. The prawn, however, is worth looking at. In his armour of shell, jointed like the armour of the knights in the brave days of old, the prawn goes wandering this way and that over the sand and rocks in search of adventure—and finding it.

The prawn looks like a caricature of an ordinary land animal. He has a head, a chest, a stomach, and six legs to walk on—the first pair of legs being rather like arms, with nippers for hands.

Down the stomach of the prawn are five pairs of "swimmerets"—hairy flippers or paddles which propel the prawn through the water; and right at the back, or tail, of the prawn, is a rather larger sort of paddle that is like another pair of legs.

The prawn has a pair of eyes, each at the end of a stalk springing from his head. These eyes stand up like periscopes and can be most usefully swivelled round. They are the kind of eyes known as *compound*, which we shall look at more closely in our book on insects. Between the eye-stalks is a strong beak with tooth-like ridges and under this is the proper mouth of the prawn. Indeed, it is said that the prawn has six mouths, though these are really six pairs of teeth, all of which are often at work at once, passing on the munched food to the proper mouth beneath.

There are many interesting things about the body of the tiny prawn. Pick one up, and look at him in the palm of your hand. Your hand is closing over him—and twitch! he is away, leaping to the other side of the pool. He can jump like the grasshopper (who belongs to the same race:


PHYLUM CHORDATA
FISH GROUP
TWO CLASSES
SELACHII (CARTILAGEOUS)
PISCES (BONY)
A fish is a vertebrate adapted for a purely aquatic life, propelling & balancing itself by means of fins & breathing oxygen from the water by means of gills fishes form the first markedly successful class of vertebrates There are probably more than 20,000 species of fish in the world today & more fresh forms are discovered each year Selachians represent the most ancient group of living fishes, & they differ as widely from Bony Fishes as do the latter from Amphibians They possess cartilageous skeletons, have a single nostril each side (Bony fishes have two) & the body is not clothed in scales Bony Fishes must have originated from very primitive Selachians
LUNG FISH
YELLOW-TAIL
GAR FISH
JOHN DORY
SCULPIN
BLACK SEA TURBOT
SPINY DOGFISH
PARROT WRASSE
OLDWIFE
SKATE
GURNARD
BLUEFISH
REMORA
STRIPED WRASSE
PLAICE

phylum *Arthropoda*). By making a flick of the whole body the prawn can leap out of a rock-pool or a pail of water. This acrobatic gift is a great safeguard to the prawn in the fierce life-struggle in the salt sea-pool.

We are not yet done with the wonders of the prawn. He has a marvellous power of changing his colour to blend with the colour of his surroundings. He excels even the famous chameleon in this power ; and some kinds of prawns are called chameleon prawns. Even the ordinary prawn of the sea-pool will blush red when among red seaweed, will go pale green when on green seaweed, and will darken to dark blue as the night comes on. Here in the clear sunlight and crystal waters of our sea-pool the prawns are as transparent as glass.

But let us determine to catch a prawn, to hold him in our hand and examine him with our eyes. You roll up your sleeve. You plunge your arm into the pool. Your hand closes over a prawn, and you lift him out into the sun. You dare not open your hand, for fear he may escape ; but you cannot see the prawn in your closed-up hand. So you decide to hold him by his leg. You grip one of his legs between two of your fingers, and you open your hand.

Twitch ! the prawn has leaped out of your hand into the pool, leaving his leg between your fingers. We need not feel sorry for the prawn ; he will grow another leg. He broke his leg on purpose, in order to get away. Many seashore creatures can do the same thing—crabs, for instance, and starfish. These creatures can break off their limbs on purpose. There is a special weak place on the limbs where they are easily broken, and where the wound is quickly healed up ; and where, after a time, a new limb grows. The breaking of a limb in this way is called *autotomy*. The growing of a new limb in its place is called *regeneration*.

It appears to us a wonderful thing for any living creature to be able to grow new parts of itself ; and yet, as a matter of fact, the same thing happens when a man cuts himself and the wound heals up. When a wound heals, new flesh

and new skin grow in place of the bruised and broken matter ; and this is exactly the same process as the growing of a new limb by a prawn, a crab, or a starfish.

This sort of thing is easier to understand if you remember that every part of every living body is made up of millions of living cells, each with a life of its own, though all are joined in the flesh. Once we know that all the elements of life are in every cell of the body we can see how growth can come about from any group of cells which are ready to do the work. In most of the higher animals the cells cannot grow new limbs if these are suddenly lost ; and this seems to be because in higher animals the groups of cells in each part of the body are kept working so hard at their special tasks—muscle cells, digestion cells, brain cells, nerve cells, eye cells.

In simpler, lower forms of life, the cells lead rougher-and-readier lives, and many of them are prepared to turn to rebuilding work, if occasion rises, as a settler in a rude land may be ready for any task.

In our sea-pool there are several crabs. At first glance the crab appears to be a very different creature from the prawn and the shrimp ; though as we come to look at him more closely we see he is in reality very like them. He is their cousin, and both belong to phylum Arthropoda, family Crustacea.

Like the prawn, the crab is covered with jointed armour, though the crab's armour is a true shell, thicker and heavier than that of the prawn. The crab has compound eyes on stalks, and he can telescope these eyes into sockets ; but he is a much bigger creature than the prawn, and whereas the prawn moves mainly by swimming, the crab moves mainly by walking.

The crab can walk backwards, forwards or sideways (either side) with equal ease ; and he looks rather comic when walking, for each one of his eight legs takes its own time—that is to say, the legs never keep step. You can put up a good imitation of a crab walking sideways if you cross your two wrists and lay them on a table with your fingertips

on the surface of the table. Then move your hands sideways by moving your fingers with a walking movement—the fingers of one hand pushing, those of the other pulling. Your fingers equal the number of legs possessed by a crab, while your thumbs quite neatly represent the thick claws with which he seizes his food. Those claws are armed with powerful nippers, as many a paddler in a sea-pool has cause to remember.

We will remind ourselves of the abundance of life in the sea by noting that there are more than a thousand different species of crab in all parts of the world. These range in size from the common crab of our seashore, who may be three or four inches across his shell, to the giant crab of the Sea of Japan, whose body is a foot broad and eighteen inches long, and whose legs may stretch fifteen or eighteen feet from tip to tip!

There are land crabs as well as sea crabs—the large "robber crab" or "coconut crab" of the Indo-Pacific Islands climbs palm-trees to get the fruit, and giant hermit crabs, although they are sea creatures, raid birds' nests inland on many Pacific islands. There are swimming crabs as well as walking crabs—some species have the ends of their legs flattened into paddles for swimming.

There are crabs that walk about carrying sea anemones in their claws—they do so for the same reason that the soldiers in Malcolm's army carried boughs from the wood of Birnam in *Macbeth*. (Sea urchins, too, anticipated Shakespeare in this manœuvre.) With the same idea, the long-legged spider crabs plant out on themselves all sorts of seaweeds, which, being rooted, grow there as complacently as they grow upon rocks. It is no uncommon sight to see some species of crabs with a mass of creatures growing on their backs, completely hiding them. Sea anemones, sponges and seaweeds that grow on a crab's shell have no objection to being carried about the sea-world by the crab, for they will often share the crab's meals, and anyway a great deal more food will come their way.

The crab is not only concealed by the flowery tentacles of the anemone, but if he is attacked those stinging cells of the anemone make a good rearguard to the crab's nippers. Two creatures of a different kind living together for each other's good in such a way is called *commensalism.* The hermit crab of the British coasts almost always has a sea anemone companion in this way ; but we will look at the hermit crabs in a moment ; before we have done with this strange partnership it is interesting to note that sometimes, instead of a crab catching an anemone and placing the " flower-animal " upon his shell, an anemone will deliberately climb upon the back of a crab. In such a case, as soon as an anemone is brushed by the leg of a passing crab, he clutches and folds himself around the crab's limb, and from there gradually mounts up the crab's shell till he rides on top like a mahout upon his elephant.

But of course such free rides add to the dangers of life. The life of a crab is a round of danger from birth to death. Enemies lurk on all sides, and the crab must be pretty spry to live out his full time of seven or eight years. He is a born fighter, and a cannibal ; but when we follow his adventures, and see what perils he has to come through, we may not wonder that he has a fierce and restless spirit.

He begins as a tiny egg shed by his mother. Mother crabs do not abandon their eggs as we have seen is done by so many creatures of the sea. Crab mothers carry their eggs about with them, tied to their " swimmerets " by delicate threads. These swimmerets are not so big as those of the prawn : they are feather-like nets of hair on the stomach, tucked under the crab's body.

Each mother crab as a rule carries about 4,000 eggs ; and you may judge from this that these eggs are of no great size : they are about as big as the dot on an i. When the eggs split open, the little creatures that break free may be very nearly as large as a small pin's head. These little creatures are at first quite unlike their parents. They have round transparent bodies, armed with long spines, and long jointed tails. The eyes are not stalked, the legs not yet

developed. After casting their skins several times as they grow in size, the legs begin to appear and the creatures grow more crab-like, until they assume the perfect crab form.

They soon grow an armour which is at least as strong as the armour of the prawns and shrimps, and a strong spine grows along the back of their tiny shell. Through the summer months millions of these *larvae*[1] and little crabs are swimming, fighting and feeding in the world of the shallow waters around the coasts. They are a prey to every creature who does not despise such small morsels of food. Jellyfish and sea anemones, blennies, gobies and swimming worms will clutch dozens of them ; great fish like the mackerel will gobble up a hundred or so in a few minutes. Those crabs which survive will continue to grow. . . .

But the trouble about growing when you are a shell-fish is that your *shell* will *not* grow : we have seen that shells are dead things, and dead things cannot grow. You can't grow bigger than your shell. The crabs have solved this problem by growing in *spurts*. When they are ready for a spurt of growing they squeeze themselves up as small as they can, and slip out of their shells. This is called *moulting*. Once they are out, they are soft and defenceless, and creep away into the darkest rock-crevice or the thickest tangle of seaweed, where they grow as quickly and as big as they can.

In a week they will have grown to perhaps nearly twice what they were,[2] and a new hard shell will form over them. This shell will harden in a few days, and the crab will be ready for adventures again.

It is while they are in a shell-less state that they often fall victim to some other crab who wears his shell, and who has little difficulty in slaying his defenceless brother, whom he promptly proceeds to eat. It is the moulting time which enables a crab to grow a new limb when one has been

[1] Larvae is the name given in general to the young of creatures born in a shape unlike their parents.

[2] It is believed by some biologists that when a crab moults, every cell in his body splits in two and the two halves grow to two full cells. That doubles the size of the crab.

broken : the new limb grows out even more rapidly than the rest of the body, and the new shell will of course have a new armoured sleeve for the re-grown limb.

There is one rather odd sort of crab, whose shell protects him only in front, like a shield, and who seeks to protect his soft back by crawling into the empty shells of molluscs. This crab is called the hermit, because of his habit of dwelling in old shells, like Diogenes in his tub.

When the hermit is very small the empty shells of winkles and such small creatures are big enough for him. But, like Alice in the neat little cottage of " W. RABBIT," he grows out of such shell-homes, and he has to seek larger and larger shells. He is ever having to set off house-hunting again—unless he is like that unfortunate crab who crept into a glass bottle to grow—and, alas ! never calculated his rate of growth carefully enough, and could never get out again !

The hermit pokes his periscope eyes into one shell after another until he finds a goodly home ; and, once he is comfortably settled in, nothing but another spurt of growth will ever induce him to leave it. It is his only protection in a cruel world, and, like a gypsy with his caravan, the hermit takes his shell-home everywhere with him, dragging it awkwardly over the rough sea-bed, up and down rocks and hills and valleys in the deep. Even if he has to fight another hermit crab, or one of his countless enemies, he will always be clinging tightly to his shell-home by several hooks which he grows on his tail for the purpose. The wisdom of his home-loving disposition shows itself in that even when he goes into battle—and hermits engage in battles on the sea-floor, as men do on land—this movable dug-out prevents him from getting seriously hurt. Not a bad sort of battle, really.

Yet one day when he is house-hunting he may catch sight of the ogre of the crab world. That may happen any day to any crab of the 1,000 species of crab. Perhaps the ogre will be surrounded by piles of crab-shells—disjointed shells and scattered legs and claws—witness to the monster's awful appetite. Or the great ogre may be swimming through the

deep or creeping round the rocks : the crab may first see one arm, then another arm, then arm after arm coiling like snakes round the rock. For the ogre has eight arms, which is why he is called octopus.

When he sees the ogre the crab raises his claws in a fighting attitude, and waits. Eight long arms—arms that taper away to thread-like ends, which can curl into the shell of a crab's claw and scoop out the soft flesh from inside —wave their way towards their waiting victim ; and when they get near to him, he will not run away ; and when they seize him, he will not fight. It seems that the very sight of the ogre has struck the crab numb with terror.

Then the octopus lifts the crab and, holding the victim in several arms, pulls him to pieces, and carries the pieces to the pointed beak and the mouth in that dome-like head.

The octopus is the greatest of the molluscs and belongs to the family *Cephalopoda*, which means " head-legs." His eight legs (or arms) spring out of his head, and he has no body ; or, more truly, his head and his body are joined together without a neck.

In general shape the octopus is not unlike the sea anemone, though he lives other-side up. His eight arms (tentacles) surround a mouth. They begin several inches thick, and, as we have seen, they thin down until at the ends they are no thicker than wavy blades of grass.

These tentacles are studded with suckers, little round knobs with flat bottoms that will stick on to any object. On each tentacle there are about three hundred suckers, and it is these suckers which enable the tentacles to exert their " pull."

The average octopus has a body about as big as a coconut and the tentacles are about three feet long—that is, about the length of a man's arm. Yet, as a matter of fact, tales of horror about the octopus are really a libel upon this mollusc, who lives almost exclusively on shell-fish and has a shy and retiring disposition. His mouth is very small, and you could not push a lead pencil into his throat. The octopus has hardly any bone or shell.

At the back of the pool is the littlest cousin of the octopus —the little squid called " sepiola." He is the smallest of the squids, and is about the size of a big horse-chestnut, or perhaps a ping-pong ball. The largest of the squids is one of the giants of the deep, and reaches 40 feet : 19 feet long in body, the long arms 29 feet. Even his eyes are enormous—about the size of soup-plates. The squids are as ugly and savage as any creature in the deep.

All the squids have *ten* tentacles—eight short ones— in a circle round the mouth : each tentacle having a single row of suckers, like a close-set row of coat buttons running from the mouth to the tip of the tentacle. Beside these eight short tentacles they have two long ones that rise from beside the mouth. These long tentacles have scoops like cups growing at their ends, and these cups are filled with suckers.

We are lucky to have found the squid " sepiola " in our rock-pool. It is just by chance that he has been cut off by the tide, for the squids do not commonly lurk beneath rocks, like the octopus. They swim about actively in the sea. They get along quite quickly in jerky movements. They do not live entirely on crabs and other shell-fish, but attack the true fish that swim in the open sea. Very large fish are not safe from the attacks of squids which are but seven or eight inches long ; and the " sepiola " of our sea-pool would not hesitate to attack plaice, skate, bass or flounder, much less the little blennies and gobies in the pool.

The squid's hunting is a horrible affair ; and we soon realise that the terrifying tales told about the octopus are better applied to his cousin. Squids stick themselves on to the side of a swimming fish. By the aid of their eight short tentacles, studded with suckers, they cling to the fish's skin. Inside his short tentacles, between the two long tentacles, beside the squid's mouth, is a sort of double beak, like a pair of scissors, that cuts a hole in the side of the fish to which they are clinging. Into this hole go the two long tentacles with their cups of suckers, to scoop out the

soft living flesh of the fish, and draw it into the mouth of the squid.

Very horrible, but very wonderful, all the same. The squid is really a wonderfully planned creature. If the fish-victim wriggles and lashes like a whip to get away, he can never shake off the squid, because

(1) Each sucker on each tentacle of the squid has a circle of sharp, hooked claws, pointed inward, which act like the barbs on a fish-hook to keep the tentacles in place. In case that is not enough

(2) Each sucker on each tentacle has a sort of piston of flesh inside it. This piston can move up and down. When it is drawn up by the squid it makes a vacuum which causes the tentacle to cling tighter than ever to the skin of the fish the squid is eating. In case these are not enough

(3) Each tentacle has muscles of a sort in it that stretch and pull like elastic or a spring—they " give " if the fish-victim lashes suddenly, and so the suckers are not likely to tear the skin of the fish and the squid be thrown off.

These things are all to aid the squid in attacking and securing his food : the squid is also most wonderfully fitted out to defend himself against attack.

Where the tentacles join the head of the squid is a sort of double-barrelled gun made of a couple of tubes side by side which the squid uses for breathing—one tube to breathe in fresh water, the other to breathe out. The squid can fill both these tubes with water at once, and shoot out the water rapidly, which sends the whole creature bouncing backwards like a football that has just been kicked. He does this when he wishes to leap out of danger. The octopus can do the same.

The squid also uses his double-barrelled gun to set a " smoke screen " round himself when he is attacked ; though it is not smoke but a black inky fluid which he makes and keeps in a bag in his body. When this is shot out of the twin tubes it spreads in the water, hiding him. The octopus also has this device, but he does not use it

so often as does the squid, being more of a gentleman than his cousin.

The squid can obtain his meals in several other ways beside the gruesome manner we have described. He often darts in among shoals of fish, and, seizing one in his two long tentacles, bites the fish in the nape of the neck, killing it instantly. The eight smaller arms then hold the fish while it is being crunched up by the beak.

Naturally the squid has his enemies, who make a meal of him in their turn. Every creature in the world of nature hunts some other creatures and in turn is hunted ; and, although this is a terrible and tragic struggle—" nature red in tooth and claw "—the living creatures of the world have attained a sort of balance together, some species providing enough food for some others without getting all killed off ; and these, in turn, killing their food without destroying the species they feed upon. A moment's thought will tell you that such a balance *has* to be ; and where such a balance is not reached, a whole species of creature, and sometimes many species, disappear off the face of the earth —as the scientists say, species become *extinct*. (There are, of course, many reasons why a species of creature may die out : this is only one reason.)

Of course the squid's enemies are fierce and terrible monsters. There are squid-hunting whales ; and one of the most terrifying sights in the ocean jungle, they say, is a fight between a giant squid and a whale. Yet one of the commonest enemies of the squids are those most lovely of all the living forms associated with the sea—the sea-birds. Many sea-birds feed upon the young and small squids who swim in the surface waters.

Before we turn to the sea-birds, we have yet a few more creatures to observe in our sea-pool.

Over there in our sea-pool is a starfish, that quaint creature with five legs (or arms, if you like) joined together by a quite small flat body in the centre. His skin on top is rough and spiky, the spikes acting as a protection against foes. Under each arm is a groove running from the tip of


the arm to the body. In each of these grooves are two rows of little tubes, called the tube feet. On these feet the starfish can move at a good pace ; and in rough weather, or when he is attacked, he can make his feet draw him beneath the sand.

The tube feet are really little suckers, with which he can cling on to things. Indeed, at clinging the starfish can beat the limpet hollow.

The starfish lives mainly upon shell-fish—especially upon *bivalve molluscs*. He will crawl on top of a mussel or an oyster, and, planting some of his limbs with their rows of sucking feet upon one of the shells, and other limbs upon the second shell, he will pull. . . . A starfish will hunch himself up, standing on the tips of his five legs to pull open a mussel or an oyster. The poor shell-fish will be savagely holding his two shells together until he is exhausted, when the shells will fly apart and the starfish will gobble up the

creature in the shell. The starfish has a mouth in the middle of his body, like a sea anemone, and he will suck the mussel or the oyster into his mouth in an odd and not at all a pretty manner. Some of his stomach comes out of his mouth and wraps itself round the living meal !

The battle between starfish and oyster may be a quiet and long-drawn-out affair—not much to look at, but a wrestling match in which titanic strength will be used by each creature. It is said that the starfish can exert a " pull " of 300 pounds to the square inch.

We may at the moment be thinking that the starfish is a horrible monster ; but many forms of starfish are as lovely as anything to be found in the seven seas. The rosy sun-stars, the beautiful cushion stars, the brittle stars and snake stars, are often of flower-like beauty. The starfish are experts at growing new parts of themselves.

In some kinds of starfish, when an arm is broken off, not only does the old starfish grow a new arm, but the broken-off arm may sometimes grow other arms and become a new starfish. When removed from a rock-pool to the palm of the hand a brittle star will often *autotomise* his arms, one after another, until little but the flat disc-body remains in the centre !

Over there in the pool is a cousin of the starfish, the weird sea-urchin, or sea-hedgehog as he is sometimes called. They both belong to the phylum *Echinoderma*, a name which comes from the Greek word for a hedgehog. The sea-urchin looks rather like a chestnut-burr. His prickly shell is dome-shaped, and is made up of a number of plates, like the sides of a battleship. These plates have several tiny holes in them through which the creature pushes the soft tube-like feet by which he crawls. The sea-urchin does not always walk by means of his feet. He has a very big mouth, called the " lantern " ; and in the lantern are five big teeth—so big in proportion to the creature that if we had teeth that size they would be as large as carving-knives. When the tube feet are unable to gain a foothold on fine sand or mud or on slippery rock surfaces, the sea-urchin moves by

swinging his mouth forward and digging his teeth in the surface and hauling. He must be one of the very few creatures in the world who walk on the tips of their teeth! His tube feet he uses as arms just as often as he uses them as feet; and objects will stick to the end of these tubes and be brought down into that capacious mouth. By means of his tube feet the sea-urchin often gathers bits of seaweed and other things which he prongs upon his spines to hide himself from enemies, so that he is often difficult to find under his camouflage coat. The spines are mainly for defence against foes (and very effective they are, too); these spines can be moved at will, for each spine is jointed, like our shoulders.

When a sea-urchin is feeding, spines, tube feet, and teeth may all be working at once to grab food and carry it into that yawning mouth.

# CHAPTER V

# SEA BIRDS

WE CANNOT LOOK anywhere along the coast without seeing many hundreds of one family of sea-birds, the gulls. They are congregated on the wide stretches of sandy beach. Beneath the cliffs they wheel and call. Over the waves they are skimming and floating.

Next to the roar of the sea-waves, the plaintive wails and angry cries and joyous, almost human voices of the gulls are the sounds most characteristic of the sea-coasts.

There are more than forty species of seagull in the world, ranging from big gulls with bodies two and a half feet long and wings one and a half feet from body to tip, to gulls with a body-length of not more than eight or ten inches and wings with a span of less than a foot from tip to tip.

All the gulls have short necks, short legs and webbed feet ; and they nearly all have the body and tail white, some having the wings and back black or grey, with sometimes a touch of brown here and there, and now and then a black or grey hood upon the head. Sometimes there is a tinge of pink among the white feathers.

Further colours may be added to many gulls by their legs, feet and beaks, which are black, brown, greenish, yellow, pink, red, or several of these colours, according to the species. There is in some gulls a bright yellow or red ring round the eyes. The gulls have nostrils on the upper beak, half way to the tip.

The beauty of the seagulls is enhanced by the grace and ease of their movements on the wing. Some species have a wonderful mastery of the air. By wheeling and tilting

their bodies to take advantage of air currents they can sail with motionless wings for long periods.

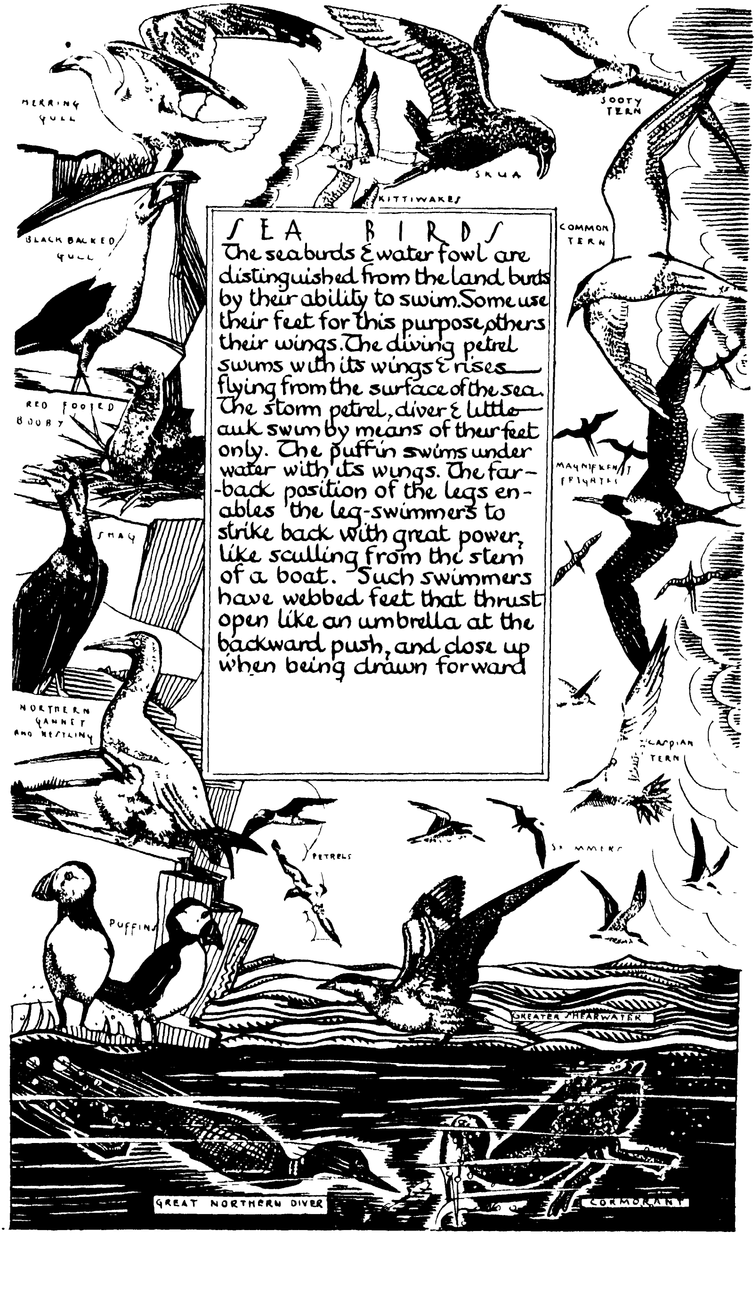
The gulls, save for one species, are not open-sea birds, but coast birds : indeed, many species breed far from the sea, making nests on tussocks in lakes and swamps, and even occasionally in bushes or trees. Most gulls, however, have their homes on ledges of cliffs, on low islands or rocks, on sand-hills or beaches ; and even those nesting inland live upon the sea-coast most of the year.

Gulls generally lay two or three eggs, never more than five or six. Their nests are usually fairly stout constructions made of seaweed, grass and sticks. Their main food is provided by the fish in the surface waters of the sea, but as a rule they will eat anything that comes their way. They are the scavengers of the seashore, and as such are useful in keeping many river-mouths and tidal harbours cleaner and fresher than they would otherwise be. Anything eatable that will fit between the upper and lower mandibles[1]—that is, the top and bottom beaks—is grist to the mill of the gulls. They will eat the grain out of the farmers' fields, and with equal relish they will gobble the earthworms thrown up by the plough. We see them treading the sands for members of the innumerable company of sand-worms, and we see them snatching the shell-fish off the rocks, flying with them over the rocks and dropping them on to the rocks to break the shells. We watch them diving to snatch small fish out of the sea—though with one exception the gulls are not good or graceful divers. The one exception is the kittiwake gull, who is the only true ocean gull.

The commonest gull of the northern hemisphere is the herring gull, sometimes called the silvery gull on account of his mixture of ivory white and pearl grey colouring, which often makes him flash in the sun like a streak of silver. He has a yellow beak with a red spot where the upper and lower mandibles meet. His legs and feet are a pink flesh colour.

The herring is a middle-sized gull, and is found swarming

[1] The upper mandible is often called the maxilla.


SEA BIRDS
The seabirds & water fowl are
distinguished from the land birds
by their ability to swim. Some use
their feet for this purpose, others
their wings. The diving petrel
swims with its wings & rises
flying from the surface of the sea.
The storm petrel, diver & little
auk swim by means of their feet
only. The puffin swims under
water with its wings. The far-
-back position of the legs en-
ables the leg-swimmers to
strike back with great power,
like sculling from the stern
of a boat. Such swimmers
have webbed feet that thrust
open like an umbrella at the
backward push, and close up
when being drawn forward
HERRING GULL
SOOTY TERN
SKUA
KITTIWAKES
BLACK BACKED GULL
COMMON TERN
RED FOOTED BOOBY
SHAG
NORTHERN GANNET AND NESTLING
CASPIAN TERN
PETRELS
PUFFINS
GREATER SHEARWATER
GREAT NORTHERN DIVER
CORMORANT

all round the coasts of Britain, from Land's End to John o' Groats ; many thousands of these gulls wing their way inland in winter and invade the ponds, rivers and lakes : they are found by the hundred in London in company with several other species.

Herring gulls nest in colonies, sometimes in company with lesser black-backed gulls. It takes four or five years for the young to grow up to full gullhood, and they are fed and cared for by their parents for some time. The lesser black-backed gulls are an inch or two smaller than the herring gulls. They have darker grey feathers and yellow legs and feet.

The so-called " common gull " of British waters is not nearly so common in Britain or elsewhere as are the herring and the lesser black-backs. The general name for the common gull is the *mew*, or *sea-mew*. The mews are almost all white in the summer-time, save for a band of black near the tip of each wing : in winter their heads and backs are streaked with grey : their bills (beaks) are browny-yellow, their legs and feet pink.

We have said that the only true ocean gull is the kittiwake, who is also the best diver among the gulls. This bird is very like the mew, only a slight change in the black wing-feathers and the grey streaks marking the difference. The kittiwake is, however, a rather smaller bird than the mew, and is quite the most beautiful of the gulls. When I say he is an ocean bird, I mean that, unlike all the other species of gull, who spend so much of their time on the cliffs, rocks and beaches, the kittiwake comes to the coasts only once a year to make his nest and to care for his young : for the rest of the time he lives upon the open sea, where he " lightly rides the moving walls and sails the great winds."

The real sea-birds sleep " rocked in the cradle of the deep " ; and they live entirely upon the fish and other sea creatures who swarm in the surface waters, one or two kinds preferring young squids to any other item on the ocean menu : some of these wild sea-birds come in close to the

shores at certain times of the year. I have sat for hours on a low cliff in North Cornwall round about Christmas-time watching the antics of a great northern diver. He would float lightly on the dancing waves, then leap right out of the water into the air and plunge head first into the sea. He might remain under the waves for one, two or three minutes—they can actually stay under the water for eight to ten minutes—then rise up with a wriggling fish dangling in his beak. A toss of his head, a swallow, and the fish was gone. Then he would shake himself as if in satisfaction, or perhaps as an aid to digestion, and in less time than it takes to tell he would leap and dive again.

The great northern diver looks at first as if he were black. Actually, he is mottled in parts, with a chess-board pattern of black and white, and parts of his throat and chest are white ; yet there is far more black than white on him, and his black plumes are bright and glowing, like polished ebony, though with that glint of green one observes in the blackbird. He has a blue-black beak and dark green legs. The diver—he is sometimes called the " loon "—is a very odd-shaped bird, with a long, thin neck, a lozenge-shaped body with the wings set a good way towards the back, and the legs almost at the end of him. Among sea-birds, the further back the legs the better for diving, as legs in the middle of the body interfere with the " streamline." But legs almost at the tail are awkward for land-walking, unless they are fitted with feet like the penguin's. The great northern diver can hardly walk on land at all, and he cannot take flight unless he swoops down from a rock like a glider, or swims for a " take-off." Once in the air, however, he can fly long distances at a good speed. The diver nests in Greenland, Iceland and the Arctic, and in winter numbers of these birds fly as far south as the Mediterranean.

The great northern diver is a big bird, with a body nearly three feet long, each wing having a span of more than a foot. That more famous sea-bird, the storm petrel, is a little six-inch fellow, the size of a starling. Like the diver, the little storm petrel can rise on the wing only if he gets a

" take-off." St. Peter in the Bible tried to walk upon the water, and the petrels are named after him because they run on their webbed feet over the ocean surface in order to rise in the air.

The only glimpse we are likely to get of the storm petrel is his dead and battered body thrown up now and then after some great storm on the ocean. He is a tiny bundle of wind-blown feathers who spends all his days, save for a brief resting-time, soaring over and settling upon " the always wind-obeying deep." He is as black as soot save for a glimmer of white in his tail.

The tiny storm petrel's big brother is the far-famed albatross, a giant bird who may be more than eleven feet from wing-tip to wing-tip. The albatross is probably the finest flyer of all birds, his mastery of the air making the kittiwake look like an amateur. One odd thing about many of the deep-sea birds is that parent birds lay but one egg every year. This is the case with storm petrels, albatrosses, gannets and several others. The egg of these birds is laid upon storm-tossed rocks and tiny islands, like the Bass Rock, where few enemies are to be found, and so in peace and security the young are tenderly cared for, often for many weeks. We shall see but few of these, the true sea-birds, along the beach : though when you visit a rocky coast where there are wild lean headlands and fair-sized island-rocks standing a little way out to sea, you can be sure of an adventure if you take a small boat round to the sea-face of the outermost rocks. There you will come in view of legions of strange birds.

I have spent many hours upon the island of Annet on the outer Scillies, off the coast of Cornwall. Annet is a low-lying sandy island, less than a mile long, and not a quarter-mile wide, covered with bracken and tufts of sea-thrift, and surrounded by dangerous rocks. Annet is known by the name of " Bird Island," from the immense numbers that breed there. It is difficult to walk across the island, because it is honeycombed with burrows made by the puffins, who dig tunnels eight and ten feet long in which to lay their

eggs. Sometimes these tunnels have branches and turnings like rabbit-warrens.

A remarkable bird is the puffin. He is sometimes called the "sea parrot," because he has a huge multi-coloured beak. This beak is bright blue at the base, bright red at the tip, and is crossed with bars of bright yellow ; and far too big for the bird is his beak ! In fact, no carnival novelty merchant could think of a funnier false nose for Cyrano de Bergerac than the puffin's natural bill. And, talking of false noses, the beak of the puffin does actually come off ! It comes off every year, and a new one is grown for the next season. This is a sort of moult, like the snake casting his skin.

The puffin, with his huge coloured nose, and his scarlet feet supporting his grey-and-black twelve-inch-high body, presents a spectacle as quaintly humorous as the Antarctic penguin. The puffin's normal movements, too, are extremely funny to watch. Though he walks awkwardly on land, he looks as if he were trying to be dignified, for he walks on the tips of his toes, rarely letting the whole foot flat upon the ground.

Those webbed feet of the puffin are, however, of more use to him than the webbed feet of most sea-birds ; for not only does he use them for swimming beneath the waves, but they also assist that gay and remarkable beak to dig the nesting tunnels. In making the hole for the nest the puffins lie upon their backs, and with their beaks and their webbed and clawed feet they burrow as successfully as the rabbit himself. In the burrow, like so many sea-birds, they lay but one egg each season, a large, oval, white egg ; and the little brown-and-white chick is fed and protected by his parents for several weeks. The young puffin is of course fed upon small fish such as sprats and sand-eels, and in the season the parents are seen coming in with eight or ten of these little fish slung across the big beak. They are held in the beak by little backward-pointed barbed hooks, which were first discovered by my friend Mr. C. J. King of St. Mary's, Isles of Scilly, and Billericay, Essex. The puffins

are true sea-birds, coming to the coasts only to breed.

On Annet, and doubtless elsewhere also, the puffins sometimes share their burrows with Manx shearwaters, who belong to one of the families of petrels, but who are of a different order altogether from the puffins. The shearwaters, too, are ocean dwellers, very riders of the sea, who got their name from the way in which they skim the tops of the waves. The Manx shearwater is a black-and-white bird, with a long thin beak having a downward hook at the end—the upper mandible hooks down in front of the lower mandible. Hooks are formed on the beaks of many sea-birds.

Perhaps the most agile bill on the sea-coast is that of the oyster-catcher, a remarkable bird found on the shores of both Britain and America. The oyster-catcher is a true shore-bird, in contrast to the deep-sea birds at whom we have been glancing. I don't know if the oyster-catcher is ever able to catch oysters, since oysters live and grow some little way out from the tide line and the oyster-catcher is not a diving bird, but a wader. The oyster-catcher is, however, a glutton for mussels.

Waiting until the bunches of mussels are barely covered with water, the oyster-catcher paddles up to them. We have seen that at that time the bivalve molluscs open their shells to allow microscopic food to drift in. That is the oyster-catcher's opportunity—he pokes his long, strong, orange-shaded bill between the shells, and spoons out the soft, delicious mussels! He uses his two mandibles like scissors to lop off pieces of the mussels that cling to the shells. "The bird works with great quickness, for if the tide is coming in the water above the mussels will soon be too deep for even a long-legged water-wader, and if the tide is going out the mussels will soon be exposed to the air and will close up their shells tightly."[1]

The oyster-catcher can even catch the limpet "napping." The oyster-catcher gives a quick firm tap to the limpet at just the right moment and at just the right angle: off tumbles the limpet!

[1] Sir J. Arthur Thomson, *The Outline of Natural History*, p. 355.

Sometimes the bird will catch a limpet on the prowl and will slip his lower mandible between the limpet-shell and the rock, levering the shell-fish off the rock and carrying him to a place where the wretched little creature can be quietly scooped out of his shell and eaten. The oyster-catcher is one of the worst of all the enemies of the shell creatures. He does not, however, live entirely on shell-fish. He runs with great swiftness along the sea-beach and plunges his powerful bill into the sand in search of insects, small crabs and worms.

The oyster-catcher is a handsome bird, larger than the puffin, and having a black head and neck, a white chest and under-part, and a mottled or grey back with handsome tail-feathers.

One thing we should note about the oyster-catcher is his apology for a nest. In strange contrast to the puffin, who labours so hard and so cleverly to make a home for his single chick, the oyster-catcher, who lays two or three eggs, sometimes four, is so lazy about nest-making that a mere dent in the ground or a slight dip in the rocks is thought to be a good enough home for his young.

Indeed, Miss Joan Harrison, who has illustrated this book, tells me that scores of these birds lay their eggs and leave them unprotected on the shingle of the lonely Cumbrian coast, in the north-west of England. " These eggs," she says, " are almost indistinguishable from the pebbles, and so are the chicks, who, when danger approaches, sit as still as the stones they resemble. . . . These birds seem sociable creatures, and stand silently together in long, long rows for hours on the gleaming wet sand, with a few birds standing apart in front and looking, in their trim black and white, for all the world like a trio of bishops facing a congregation of clergymen."

Let us not be deceived, however ; these birds do not choose quiet stretches of sand in order to listen to sermons. Just beneath the surface of this lonely-seeming beach there lie coiled up millions of queer little long-shaped creatures who provide a large part of the meals for the shore-birds.

Let us move away from our sea-pool with its fine view of cliffs, ocean and sands. Let us clamber down the rocks on to the sandy beach, and invade the hidden wonderland of those creatures who lie buried beneath the sand. It seems a pity that we cannot spend longer in viewing more of the glorious company of the sea-birds; but we append a descriptive list of British shore-birds to this chapter and we shall return to a fuller examination of bird life later on.

Look there, over the water is a majestic sight: that great white bird the gannet, with his yellow head and grey dagger of a beak, flying slowly at a great height over the restless waves. Suddenly he spies his prey swimming in the water below him, and like a hawk he plunges down headlong. Splash! he dives beneath the waters, and reappears in a moment with his prey clutched in his beak, and soars up with a mighty sweep towards the clouds. . . .

But here we are, down by the low-tide line. The tide is quite out; and numbers of sea-birds rise with angry cries at our approach. Stalking the tide-line, we see the great curlew, with his long, scimitar-like bill, and his streaked, sandy-brown plumage. His legs are green and his bill is brown, with a touch of red on the lower mandible. As we come close to him he rises with that high shrieking wail that has given him his name. He is the terror of sportsmen who come to shoot the game-birds of the shore: he will warn all the creatures on the coast of the sportsman's coming. The curlew is not a shore-bird only, but is an inland bird who can swim in the sea, and who often likes to tread the sandy beach for the buried shell-fish and sea-worms who dwell there.

Soon after we have passed by, the curlew swoops down on to the beach behind us, and that thin, seven-inch-long curved bill of his will be piercing the sand for tasty worms. . . .

## SOME OTHER COMMON BRITISH SHORE BIRDS

**Cormorant** (*Phalacrocorax carbo*). This lovely bird, which makes nests of seaweed in so many places around our coasts, is deep black, shot with bronze on the back, and in the breeding-season having flecks of white on the cheeks and flanks. In some respects like the great northern diver, the cormorant has a shorter neck and legs. Cormorants' eggs, from four to six in number, are bluish-white. They are fine under-water swimmers, and their name has become proverbial for gluttony, as they never seem to have finished their hunt for fish.

**Shag** (*Phalacrocorax graculus*). A rather smaller bird than the cormorant but very closely related, being commonly called the green cormorant ; the shag is more glossy in plumage and wears a nodding green plume at mating-time. Eggs and nest much the same as those of the cormorant, but smaller : prefers to nest in inaccessible cliffs. Also a gourmand.

**Guillemot** (*Uria troile*). A bird of the auk family, slate grey in colour, with a tinge of brown about the head, back and neck, beak and feet almost black. He has the smallest wings of any British bird in proportion to his size, his proper element being the sea, beneath which he swims with great speed with the aid of half-closed wings ; he does not use his feet in swimming. The guillemot winters in the open sea, but comes to the rocky coasts to breed in spring (May and June), remaining by the sea-coast throughout the summer. The guillemot breeds in colonies on cliff-ledges or on the flat tops of " stacks " or island rocks, laying his large single egg (very variable in colour) on the bare rock. The Black Guillemot (*Uria grylla*), a smaller variety, about as big as a pigeon, quite black in summer, black and white in winter, with scarlet feet.

**Razorbill** (*Alca torda*). Also a member of the auk family, and thus a relative of puffin and guillemot, the

razorbill is very similar to the latter in habit, though slightly bigger, jet black about the head, neck and back, with black legs and feet. The beak has several white bars ringed round it, with a white bar also from between the eyes to the tip of the beak. Pure white in front, between the wings, from neck to tail.

**Turnstone** (*Arenaria interpres*). The turnstone is remarkable as belonging to a genus which contains only one other species—a North American kind with much darker plumage. He is also a "record holder," being the most widely spread species of bird known to mankind, found in all parts of the world at one season or another ; yet it is not known for certain whether he breeds anywhere except in the Arctic circle ! A curious creature indeed ; and found on our shores quite abundantly during most seasons of the year—a small shore-bird, about the size of a thrush, with a mottled plumage of white, black and brown, with a short straight bill and short orange legs. In winter the darker parts are all black, no brown being visible. His habit of turning over stones, bits of debris, rubbish, seaweed, etc., in his search for food, may have helped him to his world-wide success in the struggle for existence. Something of a scavenger, he will eat almost anything.

**Water Wagtail** (*Motacilla lugubris*). This is not a sea-bird at all and has no business in this chapter : he belongs to the *Passeriformes* family which we describe in Book Four, Chapter VIII. Yet I do not think I have ever been down to the edge of the sea on a sandy coast without seeing several of these little birds dancing a minuet with the waves. All visitors to the coast must be familiar with them, and so a word must be said about them here. They are land breeders, but their habits of feeding lead them naturally to the watersides, to the edges of ponds, lakes, streams and rivers, no less than to the sea. They feed on seeds, insects, worms and small molluscs and crustaceans. We shall see in the next chapter what a feast awaits these greedy little birds on a stretch of sandy beach. These

wagtails, properly called pied wagtails, are small, mottled, black-and-white birds, the female having a good deal of grey on the back. The characteristically long tail twitches and swings as they run along the beach, at the water's edge, in search of their food.

**Skua** (*Larus argentatus*). Sometimes called the Pirate Bird, the great skua or bonxie, when he sees a gull or a tern catch and swallow a fish, chases and bullies the bird that has just dined, and forces the victim to give up the meal. The skuas are closely related to the gulls. Four species occur in the British Isles, and are mostly found on the northern coasts. They differ from all the gull tribe in having a black sharply-hooked beak and a general plumage of earth-brown, streaked or mottled with a lighter buff or yellow-brown. The webbed feet and legs are black.

**Scaup** (*Nyroca marila*). The most common of the sea ducks, this bird reaches us from Iceland and Northern Europe each mid-September and leaves again about the middle of June. The name is said by some to have been given it in imitation of the bird's cry, but others say it is so called " because she feeds upon *scaup*, i.e. broken shell-fish." The scaup is a true salt-water duck, breeding within sound of the breakers. Very like the pochard in appearance (see page 411) the scaup is a stout thickset duck, 18 inches from beak-tip to tail, with head, neck and chest of glossy black, rest of front and underparts white, brown stumpy tail, mottled grey-brown back, brownish wings with a broad white bar. The beak, legs and feet are greyish-blue. The female is brown and chocolate.

**Scoter** (*Oidemia nigra*). This black duck may be found from September to June on all the coasts of Britain, but chiefly in the east. A yellowish beak and a yellow-gold gleam in the eye are the only colours in the male bird, but the female is a sooty brown with whitish cheeks and throat. A big bird, 20 inches in length.

The other ducks, and water fowl, are described fully in Book IV.

# CHAPTER VI

# CREATURES OF THE SANDY BEACH

WHAT IS A WORM?

Think of the creatures in the world who are *called* worms. We hear of " glow-worms " and " book-worms," though these are really beetles. The name " ship-worm " is given to a wonderful mollusc who is second cousin to the periwinkle. The " silk-worm " is really the caterpillar of a certain moth. All of these creatures are no more real worms than the five-fingered star-"fish " is a true fish.

When we come to say what a true worm is we find ourselves in difficulties. Years ago there used to be a " phylum Vermes," which was supposed to be a phylum for all the real worms and nothing but the worms. To-day, however, scientists group the worms into several phyla. Chief of these are the phylum for the segmented worms, that for the round worms, and that for the flat worms.

The leading phylum is that for the segmented worms, phylum *Annelida*, a word coming from the Latin *annulus*, a ring. The bodies of worms in this phylum are built in *rings* or *segments*. If you strung a number of plain rings together so that their rims touched and they made a solid-looking band, you would have a good model of a segmented worm —at least you would if you put smaller rings towards each end and rounded the band in front and behind.

The common earthworm of our gardens and fields is a segmented (or *annelid*) worm ; and we shall have a good deal to say about him in Book Two. There are, however,


ıot nearly so many land-worms as there are sea-worms ; ınd we have not far to seek for many examples on this andy beach.

Here we are, on a gravelly part of the beach where here are plenty of loose stones and patches of mud. We turn ›ver some of the stones, and our eyes light upon the homes ›f great numbers of annelid worms of the family called *'hoetopoda*, which means " bristle-footed." Most of these are ›f the general shape and size of the earthworm, who be- ongs to this family ; but whereas the common earthworm s a not very pretty reddish creature, some of his cousins ıave a loveliness all their own.

In bristle-footed worms each ring has tufts of golden- inted bristles, which serve as legs for the shore species, and vhich in the sea species are flattened into paddles for wimming.

One of the most beautiful worms of the seashore is the abella, popularly called the sand peacock, whose body is

adorned with two rows of half-moon-shaped scales that gleam with tints of mother-of-pearl. Around his head the sand peacock has a crown of bright-coloured plumes, and he wears what looks like a black velvet collar. These lovely plumes are really like the " glass hand " of the barnacle, and are used not only for sweeping water and food into the worm's home, but also for breathing the oxygen in the water, acting like the gills of a fish. The "collar" is really a tool for shaping and smoothing the sides of the sand peacock's home, and is called the " trowel." For sabella builds a house for himself, as men do.

He builds a long, narrow tube around his body, using grains of sand as bricks, fitting the angles of the sand-grains together. Sabella cements together his sand-grains with a kind of natural glue with which so many creatures are usefully provided.

When the tide covers the beach, sabella the sand peacock pops his plumed head up through the end of his burrow and busies himself with capturing the small morsels of food that are swept by. When the tide goes down he sleeps in his tube, as do so many millions of worms of different kinds in the sand of this lonely-seeming beach.

Some of the worm-tubes beneath the sand " provide examples of animal workmanship so accurate and beautiful as to challenge comparison with the combs of bees and wasps and even with the nests of the most skilful birds."[1]

We may imagine how difficult it is for scientists to classify worms when we realise that the form of the sand peacock changes from individual to individual. That is to say, different sand peacocks will have eyes in different places, will have different colours in their plumes and bodies, will have different numbers of rings (segments), will have different shaped collars ; and in several other ways they will chop and change about. Such *variations* are found in many kinds of worms—*individuals of the same species* differing widely.

There are, however, enough constant features about most

[1] Flattely and Walton, *The Biology of the Seashore*, p. 102.

worms to be able to say what sort of worm they are ; and in the puddles among the low sandy rocks we can see the tubes of another wonderful worm, the serpula, who has feathery scarlet plumes and a bright red stopper that he shuts down on his tube at low tide. On many rocks we can see a number of the long twisted tubes of the serpula. These are not made of sand grains, but of the lime from the sea, in much the same fashion as the shells of the shell-fish are made.

Another plumed annelid worm on the lower tidal beach is the terebella : there are, indeed, several species of terebella, all living in tubes, one preferring to build his tube out of grains of sea-shells, which make it look like a very tiny " crazy pavement." This worm constructs very long twisted tubes that often coil over the rocks.

All along this lower part of the beach we can see little coiled piles of sand that look like worm-tubes. These are the " castings " of the " fisherman's lob-worm," *Arenicola piscatorum.* This annelid worm lives in a U-shaped burrow, and he lives by eating the sand as he pushes himself along. The cells of his body digest minute organic food, such as foraminifera, from the sand, and all that is indigestible the worm tumbles out on the surface in these coils.

The lob-worm—he is sometimes called the lug-worm—is not a beautiful worm. He has no plumes, and he has a huge cup-like mouth in front for swallowing the sand. The rings of his body " are not all alike ; those at the front being furnished with a few small, widely separated tufts of bristles arranged in pairs ; then follows a series in which the clusters of bristles are large, bush-like, and close together ; while the end of the body is without bristles."[1] He has no eyes. The lob- or lug-worm is often ten or sixteen inches long, and is dug up in great numbers by the fishermen and used as bait.

If we want a really beautiful creature, we must find the king of all the worms, the splendid *Aphrodita.* He is sometimes called the " sea mouse." He is not, of course, a mouse,

[1] Richard Lydekker, *The Royal Natural History,* Vol. VI, p. 437.

but a true annelid worm ; and sometimes he does not look beautiful, but rather the reverse. He is like a hairy slug, and his hairs act as a filter to clean out all dirt from the water which reaches his body, so that often these hairs will be covered with mud and sand ; but when they are clean they are seen to be tinted with all the colours of the rainbow.

The body of aphrodita is ribbed with ruby-red spines, and when this short, stout worm—he is about five inches long and two inches wide—is seen moving through the shallow water of a rock-pool or shimmering beneath the waves, he is like some fragment of animated jewellery. Many species of aphroditae have their eyes upon stalks.

There are, of course, a great number of other annelid worms beneath the sands ; and there are worms belonging to the other phyla, to phylum *Nematoda*, the round worms, who are not in rings, but in one piece, and to phylum *Platyhelminthes*, the flat worms, whose name describes their general characteristics.[1] There are also many worm-like creatures who are not worms, buried beneath the sand.

Among the underground dwellers there is a small quaint creature who is half-way between being a worm and a fish. He lives, like the lob-worm, by eating the sand as he pushes his way through, but he has a backbone in one single piece, like the lancelet. No worm has a backbone.

This backboned sand-dweller is called *Balanoglossus* ; and he is more nearly related to the lancelet than to anything else.

It is not surprising that there should be so many half-way creatures by the shores of the sea ; for it was here and hereabouts that the forms of life first appeared and moved upon the face of the waters. If we had time to look for them, we could probably find upon this very beach relatives of all things living. Among the vast mass of different kinds of worms alone we find relatives of arthropods, molluscs, echinoderms ; and through such creatures as the lancelet

[1] Many of these will be found described in the general list of seashore creatures at the end of this first Book (pp. 113 to 120).

and balanoglossus the worms are related to all backboned animals.[1]

In other words, there are few creatures in all the world whose ancestry does not go back to some form of worm. This does not mean we are all sprung from worms—as foolish people will say men are all sprung from apes. You might just as well say that all modern ocean liners have sprung from primitive canoes as say we have all sprung from worms. It is true that the general shape of the savage canoe is the same as the general shape of S.S. *Queen Mary* ; and certain principles are identical for both, as is the case with worm and man. Yet you could hardly say that S.S. *Queen Mary* is merely an elaborate canoe. There is so much completely new invention in it, so much material brought from all over the world, to be fitted into the unique design of the modern liner, that it must be considered an altogether new and unique thing.

Yet it is certain that there is a *line of development* through the savage's canoe to all the types of craft in history ; and there is a line of development through the worm to most of the higher forms of life. We might draw a parallel between

| | |
|---|---|
| floating log | amoeba |
| hollowed-out canoe | worm |
| S.S. *Queen Mary* | man |

If we feel that worm-form was but a stage in the development of other and finer forms, like a road that must be travelled if we would reach a great city, we must not be unfair to existing worms. They are not all half-way creatures left behind in the progress of living things from form to form. We have seen that many of the worms have attained their own perfections.

We must remember, too, that many lowly forms of life are necessary and useful to the higher forms. We shall have

[1] Such creatures as the lancelet and balanoglossus are fairly nearly related to the cyclostomes (see picture on p. 57), who are, however, more fish-like, less worm-like ; they swim and dwell in the coast waters and rivers of Europe and America.

an example of the earthworm's value to man in a later chapter.

And in thinking of the worm's place in nature, and of the progress of forms up to man, let us not fall into the sorry error of thinking that there is a need for life to grow to finer forms on every occasion. There are many creatures—on this beach, too—who seem to have slipped back from the promise of a finer life to lesser ways of living. Consider those tiny animals called "sea firs." They belong to the order hydrozoa in the phylum Coelentera. (See illustration on p. 96.)

Sea firs grow under stones and on seaweeds on many beaches. They look very like the bracken and ferns of our heaths and moors—feathery masses, for all the world like plants. For a long time they were thought to be seaweeds. These masses of fern-like growth are now known to be colonies of tiny animals, hundreds of thousands of animals in some instances, each animal dwelling in a little "room" of leathery flesh he has made for himself, all these "rooms" being joined together to form the plant-like pattern of the sea firs. These growths are often most beautiful to look at, and of many shades of colour.

These sea firs begin by one tiny animal cementing himself to a stone or the frond of a seaweed; and he has children by *budding*: that is to say, another tiny animal like himself grows out from his side; and instead of breaking away and swimming off, the new animal stays fixed to his parent, living, as it were, in a new "room," in the same body, with a door between the two "rooms." The two creatures aid each other in living, sharing the same food, and even the same blood, which flows back and forth through the "door" between the two "rooms." Both these animals may bud again, making four animals, and these will all bud, and so their numbers will grow into hundreds of thousands, all joined together. In some species these creatures will be joined together by branches as thick as the stems of small flowers: in other species they will be held together by thread-like stalks, no thicker than the

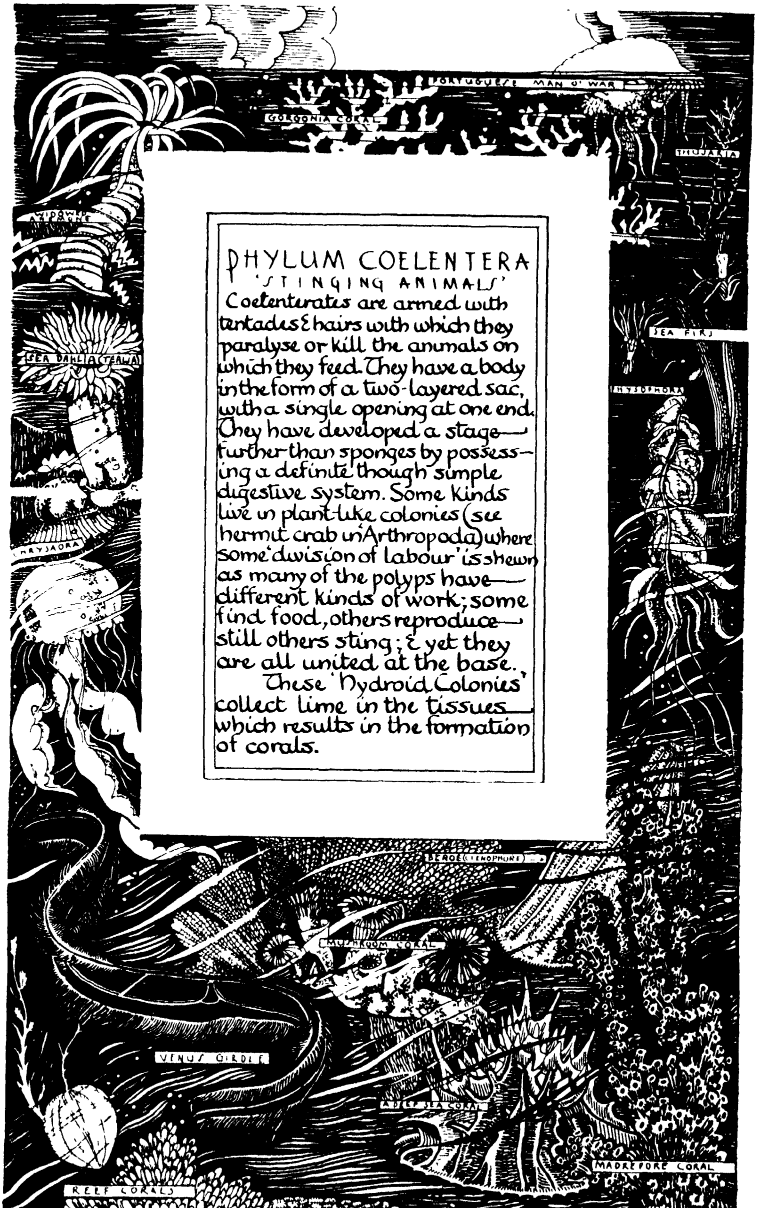
cotton on a domestic cotton-reel. Each one of these animals has a heart of his own, and a real animal organisation. Yet the heart of each one is joined up to all the other hearts, and all their hearts beat as one, sending on the blood from heart to heart through all the " rooms " of this forest of bodies. They all have mouths, and the food, too, is passed on for all to share.

You may ask how a fresh " sea fir " begins life? The answer is that at certain times these odd animals develop sperms and ova that join and swim out into the sea like tadpoles. These tadpoles grow a backbone, eyes, a bit of a brain, and they look as if they would grow up into some form of fish. But they don't grow into fish. They search about for a rock or a stone or a seaweed to which to cement themselves; and when they have found a place and stuck themselves down, their backbones and eyes and brains will shrivel and vanish, and they will become the simple animals that grow by budding and look like plants.

In this strange story of the sea firs we should notice that the splendid beginning in the tadpole's life is not fulfilled, and these creatures sink back to a simpler and more helpless way of life.

There are many species of hydrozoa and there are many creatures related to them; the " polyzoa " (" many lives ") is a term for another group which some scientists form into a " phylum Polyzoa." The life-histories of all these creatures are for the most part much like that of the sea firs we have examined. Their " tadpoles " in some cases are like little jellyfish. When creatures produce their young at one time in one way, at another time in another way, it is called the " alternation of generations."

These hydrozoa, as we have said, belong to phylum *Coelentera*, the phylum of the sea anemones, the jellyfish and the corals. If you can imagine creatures not unlike the sea fir animals, that, instead of living together in a simple leathery body, build up a big skeleton of hard lime in the form of branching plants, you can catch a glimpse of the coral polyps at work. The vast coral reefs which are found




# PHYLUM COELENTERA
## 'STINGING ANIMALS'

Coelenterates are armed with tentacles & hairs with which they paralyse or kill the animals on which they feed. They have a body in the form of a two-layered sac, with a single opening at one end. They have developed a stage further than sponges by possessing a definite though simple digestive system. Some kinds live in plant-like colonies (see hermit crab in Arthropoda) where some 'division of labour' is shewn as many of the polyps have different kinds of work; some find food, others reproduce, still others sting; & yet they are all united at the base.

These 'Hydroid Colonies' collect lime in the tissues which results in the formation of corals.

in so many parts of the southern seas are the skeletons of countless millions of coral polyps, all these skeletons being joined together in plant-like form in much the same manner as the soft bodies join in the sea firs. The coral-creatures only run their hard dead skeletons together, and these, of course, are left behind when they die, and form in the course of ages veritable walls of exquisitely patterned lime-work.

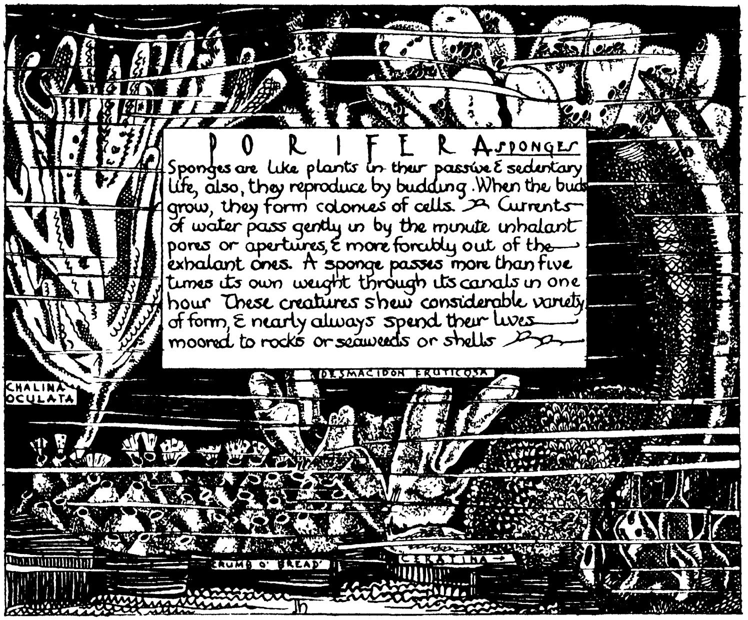
The bodies of creatures belonging to phylum Coelentera are in general barrel-shaped, are usually stuck on to something at one end, and with a ring of tentacles round the other end. Creatures of this type are called *polyps* (a silly name meaning " many feet," which really refers to their many tentacles). Not all of them, by any means, live joined together. We have seen that the sea anemones are solitary creatures. There are also several free-swimming species such as the " Portuguese man-o'-war."

Between the simplest of all animals, the one-celled protozoa, and the coelentera, there is only one class of creatures, the sponges. Small sponges of several kinds are common objects on most seashores near the low-water mark, although big bath-sponges grow only in the warmer waters of seas towards the tropics. The skeletons of sponges are not hard rocky stuff, like the skeletons of corals. The soft sponges that we see in the shops and use in our baths are actually only the skeletons of sponges.

Once upon a time your bath-sponge was covered with flesh, and it breathed in through many of the little holes it has all over it, and it breathed out through many other of the holes and got its food as well as its oxygen from the water that it breathed.

Sponges reproduce their kind in much the same way as the bladder-wrack, though they are not plants. Scientists put sponges in a class by themselves, the *porifera*. Sponges were the first of all *many-celled* animals to grow up out of the single-celled amoeboid kind of life. They are just masses of single cells clinging together and working together, though they are even less well organised than the sea firs.

The sponges have remained in their simple form, without




progress, through all the generations of life in the history of the world.

We see, then, upon the seashore, the lives of creatures going forward in some cases, in other cases we see creatures making a good start forward, then slipping back to a more simple and helpless way of living, and in yet other cases we see life standing still. . . .

Here upon this wide and lonely seeming beach we find life in all its stages.

But we must soon beat a retreat before the incoming waves. Soon the millions of sleeping worms under the sand will feel the beat of the waves over their burrows. They will wake up and stir themselves for the strife of their " day "—though they are not quite secure in their tubes during the " night " of low tide, as we can tell if we watch the long thin beak of that curlew, at work prodding through the grains tugging up a lob-worm. . . .

And even beneath the sand the worms have enemies. There is, for instance, a little devil of a long-shaped fish who swims in the coastal waters at high tide, but whose habit it is to bury himself beneath the sands when the tide goes down ; and under the sand he wriggles about almost as actively as he swims in the high-tide waters. He wriggles his way up to the worm-tubes and gobbles up the worms.

A very queer little fish he is, not more than five or six inches in length, with no ventral fins, and with a small forked tail. He is a true fish, not a worm. He is called the sand eel. The birds of the seashore sometimes strike lucky and haul *him* up and toss him down their insatiable throats.

The seashore birds can also find plenty with which to busy their bills, without striking down beneath the sands. Many portions of the surface of the sands are alive with little creatures. Down on the lower beach, near the low-tide mark, we see numbers of those very tiny crabs whose adventurous lives we followed in Chapter IV, and among half-dry seaweed and under stones and on flotsam and jetsam, we find swarms of leaping and dancing creatures, as small as tiny insects. These are not insects, although they belong to the great phylum Arthropoda, the phylum to which the insects belong. They actually belong to another family within this phylum : they belong to the Crustacea family, which is the family of the prawns, shrimps and crabs.

These leaping and dancing mites are of many kinds—there are sand hoppers and beach fleas and several more. These tiny crustaceans eat dead and decaying vegetable and animal matter on the seashore, and in turn they are eaten by their larger cousin-crustaceans, by true insects, and by many of the shore-birds.

There are also many types of real insects which are never found elsewhere than upon the shore. There is, for instance, a small, blue-black, wingless insect found on or under stones, crawling on weeds or walking over the surface of sea-pools : this insect is never found above high-tide mark nor in the laminarian zone. This insect belongs to the class called

spring-tails and its Latin name is *Anurida maritima*, and it has such a thick coating of hairs that when it is covered by the tide, air gets caught in these hairs and so the animal can breathe, and escapes drowning. By this means it can stay four or five days under water. You may be able to find the orange-yellow eggs of this insect deep in rock-crevices.

There are eight species of seashore beetle that can remain covered by the sea for a long while. There are many species of shore-flies. There is one " black fly " (*Coelopa frigida*) which is common, and is not unlike an ordinary house-fly to look at. Midges are numerous above sea-pools and their larvae are truly sea creatures, living beneath the water, feeding on green seaweed.

For an account of insect-life, however, that will assist us to study these small denizens of the shore-jungle, we must await Book Three.

# CHAPTER VII

# ADVENTURES OF THE SALMON AND THE EEL

FRESH WATER is poison to most sea creatures, though all seashore animals must be prepared for doses of fresh water at times—as when rainstorms flood the beach at low tide. Yet, among true sea creatures, there are some who swim up the rivers, into the world of fresh water, far from the sea. Chief among fish of this kind are the salmon and the eel.

The salmon spends most of his time in the sea roaming after the parties (shoals) of herring and mackerel and sprats ; and when he swims inshore with the high tide he will make a special set at the sand eels, who are a very choice item on his menu. Yet at certain times of the year this powerful and handsome fish, with his back of steely blue, his sides all resplendent with shining silvery-white scales, swims against the strong currents of fresh water in the great rivers of Europe and America.

Many salmon fall victim to the fishermen's nets that are spread for them in the mouths of the rivers at the right season of the year. Those that evade the nets swim up into the heart of the land. The salmon will leap over waterfalls, coiling his body into a crescent and twitching out straight, in order to leap over walls of roaring water. A heavy fish of 20, 30 or even 50 pounds weight will leap as high as six feet into the air in order to surmount a fall[1] ; and there is probably no more beautiful movement among all the creatures on earth than the coiling and leaping of the silver

[1] The greatest salmon may grow to more than 80 pounds weight.

salmon. The name salmon means "the leaper," coming from the Latin *salio*, "I leap."

Time and again they will leap into the rushing cataracts until they have found the place where they can leap through. In many rivers men have made "salmon ladders" to aid the fish in their fight against the flood. These salmon ladders are a series of steps of wood or stone, which make smaller waterfalls over which the salmon can more easily leap.

Men do not want to catch *all* the salmon in the river. They want to aid many of the salmon to escape up the river. The salmon are battling their way upstream to lay their eggs in quiet pools in the heart of the hills, far from the strife and danger of the ocean. Hundreds of thousands of salmon eggs will be laid in these pools ; and, when these are hatched into little fish, these little fish will in time swim down to the sea to grow into great fish as large as their parents. These great sea-fish will then in time return to the rivers of their birth, to the shady pools where they were born. And there, in their turn, they, too, will lay their eggs, and become parents.

Men have learned the ways of the salmon, the dates of his sea-going and his returning ; and men trade upon this knowledge, for the salmon is the most valuable fish in all the world. The salmon's flesh is the richest, the most delicious food the sea offers to man, and millions of pounds' worth of salmon are caught every year in Europe and America and Japan.

It is a wonderful thing, if we come to think of it, that great fish that swim the ocean should make their way up among the mountains of Europe and America and Asia, to lay their eggs. Species of salmon that dwell in the Pacific swim up the Yukon River 2,250 miles from the sea, and up into the Sawtooth Mountains of Idaho, more than 1,000 miles from the sea. The Atlantic salmon are found in one bay on the eastern coast of the United States, they are found in nearly every bay and river of Canada, in many bays and rivers in Labrador, and often in the waters of


THE LIFE HISTORY OF THE SALMON AND THE EEL
THE GREAT FEEDING GROUNDS
OF THE SALMON They ascend rivers in N America, Europe, Asia, NW Africa, Asia Minor, N Persia, the Hindu Kush, the Gulf of California & the Rio Grande
GREENLAND
NORTH AMERICA
NORTH ATLANTIC OCEAN
NORTH PACIFIC OCEAN
EUROPE
AFRICA
ASIA
SIBERIA
THE DEVELOPMENT OF THE EEL
i
ii
iii
iv
v
vi
vii
viii
Shewing the change from Leptocephalus shape (i - vii) to 'Elver' shape (viii)
EEL are found in the rivers of Europe, N Africa, Temperate Asia, N America east of the Rockies, Mexico & the West Indies. They go to sea at the age of 5 or 6 years & do not return after breeding. The young eels, or elvers, which ascend the rivers in such prodigious numbers in spring and summer are at least a year old.
THE EEL'S NURSERY
Born at least 200 fathoms down, the eel is at first a tiny leaf-like creature which gradually assumes a cylindrical shape
A E
A·American
E·European
In the rivers flowing to the Pacific, the salmon ascend in dense masses, so thickly that they appear to be a solid body. Vast numbers leap out of the waters & die on the banks. Some salmon spawn at a distance of 2250 miles from the sea.
Salmon spawning in the gravelly shallows of the cool upper waters of the rivers
THE DEVELOPMENT OF THE SALMON
I FERTILISED EGG
II EGG JUST BEFORE HATCHING
III NEWLY HATCHED ALEVIN
yolk sac
IV ALEVIN
V FRY
VI
VI FRY DEVELOPING INTO PARR
VII ADULT SALMON
ATLANTIC
PACIFIC
VIII
IX
VIII & IX HEADS OF MALE BREEDING SALMON

Greenland and Iceland. There are no salmon in the Mediterranean ; but they are found in many rivers in Spain, Portugal, France, Denmark, Holland, Scandinavia ; and in many rivers that run into the Baltic Sea.

During the journey from the sea into the mountain streams the salmon eat little or nothing. They are intent only upon making a nest and laying the eggs. Because they do not eat, these strong silver creatures that dart in shoals into the river mouths grow thin and weak on their long journey. Their silver goes dull and yellowish. Sometimes the fish turn dark, almost black.

When they have overcome every peril on the long journey they sometimes have to wait weeks, even months, in the gravelly pools, before the egg-laying season comes. Like plants that grow and blossom and fruit only in their season, it seems that salmon can hatch their eggs only at one period of the year. This is, of course, the case with the majority of creatures in the world of nature ; but few creatures have such a hard time of it as those salmon who would be parents. They "spawn," as it is called, in the early autumn, or fall, and those salmon that enter a river in the spring or summer, in order to get the best gravelly pools in which to set up homes, have a long fast indeed.

The male salmon, during his journey upstream, grows a savage-looking hooked snout. This is a useful weapon in the many fights he has with other male salmon to defend his nest and his mate ; and it seems that it is of use also to help his wife in digging a trench in the gravel in which the eggs may lie safely. The female makes a trench by wriggling her body about in the gravel, the male salmon assisting her, his hooked nose digging up the gravel like a plough. The sperms from the male salmon then float into the water like a sticky fluid, around the eggs which the female lays in the trench. Father salmon then covers up the eggs with gravel, shovelling the gravel over them with his hooked nose, aided by mother salmon, who brushes the gravel over the eggs with her tail. The two parents may dig many trenches in this way in one season. When the eggs are

thus covered up they are fairly safe for the winter. The gravel protects them and holds them in place ; and at the same time it allows enough water to trickle through to wash the eggs and keep them supplied with oxygen, the air that blows upon the fire of life.

The egg-laying and sperm-laying and nest-building being over, the mother and father salmon may be ready to return to the sea ; and well may they be eager for the downstream journey, for they are but dark shadows of their former silvery selves. Many of the parents never return. They have made such great efforts to reach the quiet pools, they have used up so much strength in making their nest and bringing forth their young, that they soon die or fall victim to some lurking otter or other natural enemy. In the Yukon River in Alaska brown bears come down to the valleys and paddle in the streams devouring hundreds of weakly wriggling salmon. In this river, few parent salmon ever make the return journey of 2,250 miles to the sea. They give their life for their young.

On the shorter rivers many of the parents get back ; and once they are in the sea and start eating again they soon put on flesh ; their scales soon regain their silvery hue, the male salmon soon lose their hooked beaks, and they are away again roaming after the mackerel shoals. They may stay in the sea two or three years and then go up the rivers again to have another family. The salmon are supposed to live not more than ten or twelve years, and lucky fish who escape all the perils of ocean and river may go up to the hills two or three times to make a home and bring forth families. Probably few go more than twice ; and most not more than once.

Before we see what happens to those eggs in the gravelly pools, let us pause for a moment to examine a full-grown salmon. Let us look at his scales. The scales of fish are curious things, and provide a sort of diary of each fish's wanderings. Not only the salmon, but many fish that have scales, carry a record of their age, their rate of growth, their good or bad feeding seasons, and even of their travels.

When young fish are hatched from the eggs tiny scales grow over the whole body. As the fish grows, the scales grow, too ; they grow by the addition of fresh rings outside the first tiny scale. If you draw a tiny circle on a piece of paper, and then draw other circles round it, one after another, you will have drawn a rough diagram of a fish's scale. The first tiny circle will be the first scale on the tiny fish. Each outer circle will be an addition to the scale grown as the fish grows.

In fully grown fish, the scales will be marked by scores of these rings, *each ring marking a period of growth.* When you know how long it takes a fish to grow a new ring on his scales, you can tell his age by counting his scale-rings. Easy.

In summer, when food is more plentiful than it is in winter, a fish grows more quickly, and the rings will be *wider apart,* because the fish will have grown more in the time it takes to grow a ring ; and so where the rings are wider apart you can tell a fish has lived through a summer, and where the rings are closer together you can tell that a winter has passed by. Through reading these scale-rings, experts can even tell what feeding-grounds the fish has visited !

Now let us return to the gravelly pools. In the covered trenches made by one pair of salmon there may be as many as 20,000 or 30,000 eggs, though probably the average salmon mother lays about 10,000 or 15,000 eggs. All winter these eggs will have lain secure in the gravel—unless a flood has dislodged them or a heavy weight has fallen on them and crushed them : they are strong eggs, though, and can bear a weight of five pounds on them without crushing. Sometimes burrowing creatures will plough them up and eat them ; and of all the eggs laid by all the salmon it is thought that not more than 5 per cent come through the perils of the winter and hatch out.

With the first warm days of spring the baby salmon appear. They are tiny, feeble, almost transparent creatures, hardly recognisable as fish at all ; beneath their gills hangs

a bag or pouch, like the feeding bag of a horse ; this is really a part of the egg out of which they have come, and it contains the yolk : upon this yolk the fish live until they are strong enough to use their mouths and hunt for food.

When they start hunting for minute animal food, they grow quickly, and become alert at dodging large fish and other enemies ; but thousands of them are snapped up by eels and trout and pike, and other hungry inhabitants of the streams. For nearly a year they live this stream-life of hunting and dodging, and then they begin to think of going to sea. Some think about it for a long time. Some take two years, or even three years, to make up their minds. Some go when they are one year old—off on the great adventure, to the heaving jungle where they are to spend their best days. Their scales get their shining silver colouring. Then down the river they go. Some are killed falling over waterfalls, many are snapped up by fish-eating birds such as terns, gulls and herons. Those that reach the estuary and battle out into the swaying seas will soon become true salmon. The vast ocean is before them, teeming with endless living food—though fraught with peril, filled with larger fish than the salmon, with salmon-eating fish of which our brave young silver creature will have to beware—sharks, whales and other monsters of the deep.

Now, in leaving the salmon and coming to the eel you may think we are leaving a romantic fish for a rather dull worm-like one. The salmon, after all, is the king of sporting fishes : you hear anglers telling of hours-long battles with 50-pound salmon in the mountain streams—and, as we have reminded ourselves, the salmon is by far the most valuable commercial fish in the world.

Yet the eel is in every respect as romantic as the salmon, and is of great commercial value ; and he is one of the most extraordinary fish in all the seven seas. Indeed, different species of eel are actually found in all the oceans. However, if we consider only the eels of the Atlantic Ocean we shall have our work cut out. For the eel's way of living is the *opposite* of that of the salmon. The eel is born in the sea

and spends his life in the fresh waters of rivers and streams !

The common eel is found in all the rivers and fresh waters of Europe and America, excepting those running into the Arctic Ocean, the Black Sea and the Caspian Sea. It has long been known that full-grown eels leave the lakes, ponds and rivers every autumn in great numbers, and go down into the cold dark deeps of the ocean. Every spring myriads of small young eels, known as "elvers," invade our coasts, and wind their way up our rivers. They are two or three years old ; and they are the children of the full-grown eels who left in the autumn two or three years before. Where is the nursery of these young eels ?

This was for many years the Great Eel Mystery. It was one of the big problems of the sea. Now it has been cleared up ! It is known now that the full-grown European eels swim to the waters south-east of Bermuda, while the American eels breed south and west of the breeding-places of their European cousins, north of the West Indies. The two species, while they meet and mingle, yet keep distinct.

Eels swim across the ocean to their breeding place, where they dive to about 300 fathoms (1,800 feet), and there the young eels are hatched. The tiny eels are transparent, the only colour about them being their eyes. They have black eyes. They are different indeed from their long serpent-shaped parents. The babies are leaf-like in form, very thin, and as clear as glass. In this form they are known as *leptocephali.* For a whole year they live and grow in the depths of the sea. When they are about twelve months old they find their way up to the warmer, sunnier surface-waters, leaving their parents, who are never seen or heard of again.

In the surface-waters there appear millions upon millions of these tiny eels : they feed upon the millions of fishes' eggs floating on the surface, and millions of them in their turn become the meals of larger fish and sea-birds. Of those that survive, the European eels take a journey of 2,000 or 3,000 miles, some of them 4,000 miles and more, across the Atlantic Ocean. This journey takes them two or three

years, and they are aided on their journey by the greatest of all ocean currents, the Gulf Stream—that vast river in the Atlantic Ocean that carries the warm waters of the Gulf of Mexico to the coasts of Europe.

The Gulf Stream flows out into the Atlantic through a narrow strait between Florida and the Bahamas. The stream sometimes flows at nearly six miles an hour, which is swifter than the quickest walking pace. Its normal rate is the same as the speed of the flow of the Rhine at Coblenz —about five miles per hour. This " stream " is really a mighty moving sea, carrying a thousand times as much water as the Mississippi. It is judged that ninety thousand million tons of water pour out every hour through the 110-mile-wide Strait of Florida into the broad Atlantic. All the steamships in the world could not carry the salt in this volume of sea-water.

The Gulf Stream, as everyone knows, flows north along the United States, leaving a wall of cold water against the coast : then it is turned off to the east by the Great Banks of Newfoundland, and flows right across the Atlantic : this part of it is generally called the North Atlantic Drift. All the way, it is getting colder and slower, and it splits up into several streams (currents) before washing the coasts of Europe. The furthest travelling and coldest of these currents is that which flows up the coast of Norway to the Arctic Circle. Even this cold branch of the Gulf Stream is warm enough to make that part of Norway habitable. Without the Gulf Stream the northern coast of Norway would be as cold and inhospitable as Alaska.[1]

Among the good deeds of the Gulf Stream may be accounted the fact that it transports countless millions of baby eels from America to Europe, taking between two and three years to do so. Every spring it carries a fresh batch. Of course millions of these larvae perish on the

[1] Where does all this water come from ? you ask. A great deal of it flows up into the Gulf of Mexico from the South Atlantic ; but the waters of the oceans are always flowing this way and that. The currents in the Atlantic make of that ocean a series of giant whirlpools : of course the Gulf Stream water flows back again by other routes.

journey, but they are so numerous that they invade the rivers of Europe like mighty armies, millions strong.

During the journey to Europe they grow in size. Beginning as frail leaves, less than an inch long, they grow to two or three inches, becoming fat, airship-shaped creatures, though remaining nearly transparent. They have curious, long, needle-like teeth which assist them to seize the minute creatures that form their food.

They reach the coasts of Spain and southern France every year in October, November and December—millions of them. In January and February millions more reach northern France. The English and Irish shores are reached in March ; Denmark in April ; Scotland in May.

As they approach the coasts their shape changes. They lose their leaf-like form and shrink to worm-like size. In this form they are known as *elvers*. They lose their transparency and flush a dark, slaty colour. All this time they have had fins. You might say they have but one fin running down their back, round their tail, and nearly half way along underneath them. The truth is, their dorsal, caudal and anal fins are joined, forming a continuous fin. They have no ventral fins, but have a pair of side (pectoral) fins. They grow true fish-scales after they have been a year or two in fresh water.

They enter the rivers as thin, round, slaty-coloured, wriggling fish, two or three inches long. There are so many of them, so closely marshalled, side by side, like ranks upon ranks of toy soldiers, that often you cannot see the bottom of the river. Like Alexander's army, they advance up the rivers in solid phalanx form.

One of the greatest eel rivers is the Severn, in south-west England. Countless millions of elvers get trapped every year in the broad Bristol Channel, and gather above that Channel in the Severn. For several weeks many men and women make a living by catching the elvers in odd-shaped nets made of willows and coarse canvas, filling pails and taking them to the " farm," where the elvers are sorted, weighed in thousands, packed in shallow boxes with some

ice, wrapped in cotton wool, sealed up, and sent in all directions for turning out alive into ponds and lakes. Hundreds of such boxes go to Holland, Germany and other European countries every year from the Severn.[1] Elmore-on-the-Severn was so named on account of the quantity of eels captured there.

In many other places in Europe there are "eel farms," especially round the Mediterranean ; for, unlike the salmon, the eels are found in vast numbers in that inland sea.

Now, imagine that mighty army of elvers swimming up the greatest rivers of Europe—up the Rhine, past the Rhine falls, into Lake Constance, and even further. Eels have been taken from water at 3,000 feet in Switzerland. A journey of 4,000 miles, from nearly 2,000 feet *under the sea* to 3,000 feet *up in the mountains*—that is surprising enough ; but you may well ask, How do they pass the Rhine falls ? They cannot leap over cataracts, as salmon can do ! Yet the American eels are found in Lake Superior ! They have passed Niagara !

These amazing little fish get round the falls *overland*. They can travel through wet grass or mud, wriggling their way like snakes. One naturalist has recorded that elvers have been seen wriggling their way up the face of a moist rock ten to fifteen feet high, the crowd of elvers behind pushing up their comrades in front.

When they are grown into eels they may reach four or five feet in length, being four to six inches round ; and these great snake-like fish will make regular land-hunting expeditions. They embark upon these adventures mostly at night, travelling snake-fashion ; they go by moist ground from pond to pond, poking their noses under everything, snapping up anything they can get hold of—frogs, toads, small fish, young birds, worms, insects, even mice and rats and the dead bodies of larger creatures they may happen to come across.

[1] Before the war 250,000,000 elvers were shipped annually from the Severn to Germany alone, several hundred millions going to Holland, Belgium and other countries.

These land-hunts may take several hours ; and you may wonder how a true fish, who is not an amphibian, can remain so long out of water. He can do so because, like the camel, he has a sort of water-tank arrangement inside him ; but whereas a camel *drinks* from his inside water-tank, and so can cross a waterless desert, an eel *breathes through* his water-tank in the way that he breathes in a pond, or in the sea, and so he can travel like a land creature, and can even, if he is cut off from ponds and rivers in dry weather, bury himself in mud or sand for weeks, waiting for rain to make a sloppy, slithery surface over which he can glide again in search of a pool or a stream.

However, eels spend most of their time in the water, floating near the surface of the ponds snapping at insects, or wriggling in the mud on the bottom, feeding on the small creatures who live there : they have been known to furrow up the precious egg-trenches of the salmon and make a meal of many thousands of eggs !

In this way, several years of their life passes—two or three years, perhaps ; five or six years, maybe. Sometimes they are in danger ; they have their fights ; but for the most part it is a quiet life, with abundant and varied food of all kinds, with the fun of the great land adventures thrown in.

Sooner or later comes the call of the sea. It is the same call which brings the salmon away from the sea—the call to hand on the torch of life to a new generation of elvers. Not all the eels hear it : some live and die in the sunny country ponds or mountain lakes, in the rippling shallow streams or in the purling rivers. But most of them hear the call, at that season of the year which is set aside for the making of eel families.

And then from the inland lakes and forest streams of Norway, from the slow-moving rivers of Holland, from the mountain torrents of Germany, from the sunlit rivers of France and Spain, from the cold lochs of Scotland, from the little winding rivers and inland lakes of England and Ireland, the members of the eel race gather to go down into the ocean.

When the call comes, the eels change colour, becoming shining bands of silver-steel. Their eyes enlarge—so that they may the better see their way across that wild wide ocean whose ways their tribe knew many thousands of years before Lief Ericsson or Columbus was born.

From the Gulf of Bothnia they start in July, from the British Isles in August, September and October. Down to the larger rivers, out to the estuaries, past the harbours, into the Atlantic. There the eels from all the rivers and seas assemble, from the Baltic and from the Mediterranean, from the Tay and the Tiber, from the Nile, the Shannon and the Severn.

And here is the greatest of all the eel mysteries. The whole army swims *south-west* : that is, *against* the Gulf Stream. That vast river in an ocean which aided them in their coming is now against them ; but they neither falter nor fail in their sense of direction ; and they dive down into the darkness whence they came, to meet their brethren from the St. Lawrence and the rivers of the United States, in the deeps around the West Indies.

There, in the black cradle where they were born, they lay their eggs. This accomplished, their days are ended. No eel parent ever returns to the surface again. None ever come back to the coasts and ponds and rivers. Instead, come those millions of glass-like leaves, swimming out on that 3,000-mile journey, and starting one more round of the wheel of life. . . .

## A FEW OF THE COMMONER SEASHORE CREATURES

One of the classes of marine worms, *Nemertinea*, contains about forty British species, many of which are common on sandy or muddy shores. Turning over a stone, perhaps in a pool left by the tide, as nemertines live in shallow water, there may often be found a coiled, shiny mass, like a piece of string twisted into a complicated knot. This is **Lineus**

**marinus,** often known as " boot-laces " or the " india-rubber worm." These worms vary from 1 inch to 30 yards in length, and have the power to extend themselves many inches. If care is taken, the ends can generally be made out, and it will be noticed that one end is rounded and the other slightly tapering. The blunter end is the head, and has sense organs in the form of eyes arranged at the side of the head, and a slit for a mouth. Occasionally, a fine thread, attached to a minute pore at the tip of the head, may be seen moving freely about. This is a characteristic of the nemertines and is called a proboscis. It is an organ of touch, protection and defence and is shot out at will through the pore. Sometimes the Lineus shoots it out so forcibly that it is expelled altogether, but a new one can be grown very rapidly.

Lineus is a flesh-eating animal, and can distend its mouth to engulf an animal considerably larger than itself. It has a brightly coloured skin, brown, red or green being the most usual colours, although sometimes they are striped.

Another class of worms found on our beaches is **Polychaeta,** the marine bristle worms, at a few of which we have already glanced. These are the animals which have long-shaped segmented bodies, each segment provided on each side with a single or a couple of bundles of *chaetae*[1] and hair-like sensory organs known as *cirri*. The two end segments are modified into " head " and " tail." The " head " has two pairs of eyes, and a hole or slit which is used as a mouth. The " tail " is a long-shaped segment, and is without chaetae or parapodia. It has, however, a pair of very long cirri. Polychaeta are free-living worms, and lead an active life swimming in the sea, or else they pass their lives in tubes like *sabella* and *serpula*.

[1] Bristles used mainly in locomotion, when they are known as *parapodia* and are practically limbs. Some of the stronger forms are used as weapons of defence or attack. They vary considerably in form, are composed of *chitin*, and are transparent, but gain colour by refraction, usually of a yellow or golden tint. Refraction is explained on p. 132.

**Opheliidae** are found in shallow water. They are rather ugly worms, with a short body, and a cone-shaped head without feelers. They are of a pearly colour, and the parapodia are concealed. Sometimes a deep groove runs the length of the body on the underside, and a row of eyes along the side of the body.

**Nicomache lumbricalis,** a very narrow worm, 2 or 3 inches long, and with 26 segments, can be found under stones in the laminarian zone. It is rosy-pink in colour, with white spots in front, and red ridges to which the chaeta are attached. It is a very fragile worm, and readily breaks in pieces.

**Capitellidae** occur pretty frequently in the sand under stones, near low-tide mark. They are red worms, 1½ to 2 inches long, and at first sight look like common earthworms.

**Nepthys** is a worm that is commonly used as bait by fishermen, therefore we can be reasonably sure of finding it under stones on the shore, or in the tubes made by serpula or sabella. It has a square-shaped head, and a large sickle-shaped gill curving down between the two branches of the foot.

**Amphictenidae pectinaria** is another of the worms that builds itself a tube to live in. This tube is either straight or slightly curved, nearly cylindrical, is made of sand grains uniform in size, and is smooth both inside and out. The tube is carried about by the worm. Amphictenidae is 1½ inches long, and consists of 20 segments, 17 of which are provided with chaetae, arranged in two opposite rows. A great golden chaeta protects the head and serves as a stopper to the tube, and the side ones are used for digging in the sand.

**Phyllodoce** is a beautiful worm. It has a flattened body, 8 to 12 inches long and ½ inch across, and is a bright bluish- or yellowish-green, with a metallic sheen, the parapodia

olive-green or brown, and the sensory processes (cirri) yellow. These long, slender worms have a number of segments, and spend their lives floating or swimming in the sea. They can be found, in the day-time, under stones and shells in the laminarian zone. They lay bright green egg-masses.

Another class of marine worms is **Turbellaria,** belonging to the **Platyhelminthes** or flat-worms. They are found in both shallow and deep water. They feed on small animals and algae, polychaet worms, and molluscs.

**Septoplanae** are thin flat worms, ½ inch to 1 inch in length, which quiver and tremble when they are disturbed. The margin of the body is transparent, and when they are creeping over the rocks they look like tissue. They may be found buried in mud, or on the under-surface of stones in pools where it is sure to remain damp and dark until the tide covers them again. The shallow water specimens are brownish in colour, and the ones from deeper water are white with a tinge of brown. They search for food at night, and either creep or swim, with a waving motion of the whole body. In late summer they breed in tide-pools, and numbers of young, 3 to 4 millimetres in length, may be found among the seaweeds and corallina.

A worm-like animal, which belongs to the Gephyrea group, is **Priapulus**. It is 2 inches long, and has a skin covered with chitinous spines. The body is folded into a series of rings, and is rather swollen in its hinderparts. To its " tail " is attached an arrangement which looks like a bunch of grapes, and acts as a gill. These animals are flesh-colour, with a somewhat metallic sheen, and are known to fishermen as " sea mushrooms." They live in U-shaped tubes, at a depth of about 9 inches ; the tubes open at each end on to the surface of the sand.

**Spotted Gunnell** (*Centronotus gunnellus*) is 6 inches long when fully grown. Very common in rock-pools. It has a long, flat, eel-shaped body, the same width from the head almost to the tip of the tail, with one very narrow fin which runs

the whole length of its back. This fin has a row of black spots bordered with white on its lower edge. The spotted gunnel is sometimes called the butter-fish, for its whole body is covered with a thick coat of greasy slime.

**Dragonet** (*Calloinymus lyra*). This is not a true rock-pool fish, but it can sometimes be found in a pool, where it has been left behind by the tide. The male and female dragonets are very different ; the male fish really does look like a tiny water dragon, with his long fins and his golden-yellow lavender-spotted body. The underpart of his body is white, and the first spine of his back fin is so long that it nearly touches his tail. All his fins are very long and very spiny, but the female's fins are small. She has none of the handsome colouring of the male fish, but is a reddish colour all over. The male fish never ventures into shallow water.

**Pipe Fish** (*Syngnathidae*). This fish is very common in rock-pools. It is so thin in proportion to its length that it is often known as the needle-fish. When full grown it is 18 to 20 inches long but no bigger round than a knitting-needle. Its body is covered with hard, bony plates instead of scales. The pipe fish has a most curious method of feeding. Its jaws are very long, but are joined together all the way along so that there is only a tiny hole left at the end through which it sucks its food. When it needs food, it suspends itself almost upright in the water, head down, tail up. Then it fills its tube-mouth with water, and blows hard. The water it expels from its mouth scatters the sand at the bottom of the pool and all the tiny buried creatures are exposed, to be sucked through the tube and swallowed. The pipe fish is a very good father. He has a pouch under his body into which the female puts her eggs, and the father carries them about and protects them until they are hatched.

**Dog Whelk** (*Nucella lapillus*). Much smaller than the common whelk (*Buccinum undatum*), and instead of being smooth and white like its relation, its shell is brownish-yellow outside,

pinkish-white inside, and is covered with a number of ribs which run down from the peak of the cone to the margin of the shell. These ribs are split up so that they look like a row of beads decorating the shell.

Whelks are flesh-eaters, and their very wonderful tongues called " tooth-ribbons " easily bore round holes in the shells of other shell-fish, and the whelks suck out the contents. Like the winkle, the whelk has many rows of teeth. The whelk's tongue is covered with about a hundred rows of sharp, curved teeth with jagged edges, which are as hard as the edges of a file. Whelks lay their eggs in clusters, each egg about the size of a pin's head, and, instead of being brittle, the shells are very tough and elastic. As soon as the eggs are dropped into the sea they begin to swell and become as large as peas.

Cockle (*Cardium*). The cockle is one of the commonest of all the creatures of the seashore and scores of the heart-shaped shells are to be seen lying about on every beach. But the cockle itself is more difficult to find, for it lives buried underneath the sand. It has a strong fleshy organ called the " foot," and with this it can bury itself at great speed. The " foot " is also used as a means of locomotion, and if the cockle is dug up and disturbed, it jumps about by means of its " foot " like a sandhopper. Cockles are great wanderers and plough through the sand at a rate of 100 yards an hour. When they are hidden under the sand, cockles draw water down through their syphon tubes, into their gills, extract the air and nourishment, and then expel the used-up water through the other syphon tube. These little squirted-up jets of water can often be seen on the edge of the waves at low tide and indicate the presence of cockles beneath the sandy surface.

Variable Scallop (*Pecten opercularis*). The "variable" scallop gets its name from the colours to be found in different shells ; pink, crimson, mauve, dark or golden yellow mottled or blotched with a variety of colours. A number

of ridges run down the shell from the hinge to the margin, and on each ridge is a row of spikes. Scallops swim by opening and shutting their valves, at the same time squirting out a jet of water which helps to drive the animal along through the water at a good speed. As it travels along it waves a fringe of long feelers all round the edges of its shell ; through these feelers it obtains its food. At the base of these feelers is a row of sensitive black dots which seem to act as eyes. The large forms are known as "clams."

Radiated Scallop. The shell of this creature also varies a good deal in colour, but is generally reddish-brown, spotted and speckled with white. This is a very rare specimen, but can always be recognised as it has only six or seven ridges running down the shell instead of the usual dozen.

Wentletrap (*Scala communis*). This creature is rare but very beautiful. It is sometimes called the staircase shell because the high, bold ridges which run round it from the narrow base to the high point at the top are very much like a spiral staircase. It is ivory coloured and is found washed up among the ridges of small pebbles which are usually to be found on sandy coasts.

Painted Top (*Calliostoma zizyphinus*). There are several varieties of Top shells, the *trochi* of scientists, all of which are very common on the sandy parts of the shore. They are conical shells, with rather flat whorls, sharply pointed tops, and show a great variety of colouring. The creatures feed on weeds, sawing off tiny pieces with their "tooth-ribbons." The Painted Top is rather large, about an inch in height, from the top to the base. It is spotted and streaked and blotched with the most lovely colours—scarlet, blue, crimson, pink, purple, white and yellow. This colouring is, however, easily chipped off, as it is only the outer covering to the shell, and the shells are "silvery," that is, they show the mother-of-pearl lining.

**Grey Top** (*Gibbula cineraria*). The conical shell of this creature is even commoner than the Painted Top, but is very much smaller and less gay in colouring. It has six flattish whorls and is yellowish-grey ; its mottled appearance is due to the zig-zag black streaks which run round. Cineraria has a large head, with two long tentacles, and two eyes on short stalks which spring from the base of the tentacles. Between the tentacles are two " head-lobes " and at the sides are two " side-lobes " with long delicate cirri that are constantly moving about. The " foot " of this animal is long and narrow.

**Piddock** (*Pholas dactylus*). The piddock is a burrowing animal and tunnels its way through rocks until they are honeycombed with its borings. These borings can often be found just below high-tide mark. Over thirty living species of piddock are known. They are used both for food and bait.

END OF BOOK ONE

# Between Book One and Book Two

# Environment and Life

# ENVIRONMENT AND LIFE

No nation among men can be understood without knowing something about its history. It can be said with equal truth that no animal or plant can be understood without knowing something of the past record of its species and genus and family and phylum.

We have seen in the last Book that the seashore has been called the cradle of life. We have seen something of the varied forms of life to be found upon the seashores of Britain. We have seen the significance of some of these creatures in the grand story of evolution, which gives meaning to so many forms and ways of life which would be meaningless to us if we did not know something about that story.

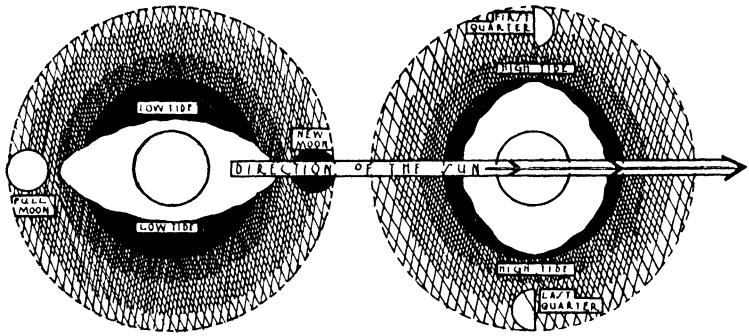
Perhaps the most important fact about the seashore, in its bearing on the history of life, is the action of the tides. It is the tides which rock the cradle of life.

This rocking of the cradle of life is the operation of a stupendous natural law which draws earth and sun and moon together. The sun—92,900,000 miles from the earth—and the moon—250,000 miles from the earth—play their part in drawing the water up the rocks and beaches of the earth, and drawing them down again, towards the deep, twice a day.

High tide is really a monster wave travelling at more than 500 miles an hour round the earth, pulled by the moon. There are two of these high-tide waves, one at the point of the earth nearest to the moon, and the other at the point furthest away from the moon. Thus there are two high tides every 24 hours, and two low tides, the low tides being the troughs between the two high-tide waves.

You can get a rough idea of the way in which two tides

THE MOON AND THE TIDES




SPRING TIDES

Extra high & extra low ('Spring') tides occur when the moon and the sun are 'pulling' in the same direction—

NEAP TIDES

Less high & less low (Neap) tides occur when the 'pull' of the sun & the moon are at right angles, i.e. against each other.

are caused by the moon if you take a toy air balloon in your two hands and press. The balloon will bulge out on *each side* of your hands. The moon, instead of pressing on the earth, pulls at it. The earth is too strongly made to bulge like a balloon : but the waters of the oceans can be moved in this way, and the " bulges " produced in the waters are the two high tides, one on each side, the low tides being where the moon pulls the water sideways across the world towards it. If you will look at our diagram above you will get a clearer idea of how the " pull " of the moon makes two high tides and two low tides, all on opposite sides of the earth.

The sun has not so much to do with the tides as the moon has, because the sun is 400 times further away from the earth than is the moon. Therefore the sun's strength—that is, its power of attraction, its " pull "—is almost spent by the time it reaches the earth. We notice the " pull " of the sun on the water only when sun and moon get in a line and pull together, so that we get extra-high " spring tides " ; and when sun and moon pull at right angles (or against each other),

then high tides are not so high as usual and low tides do not go so far out : these we call " neap tides."

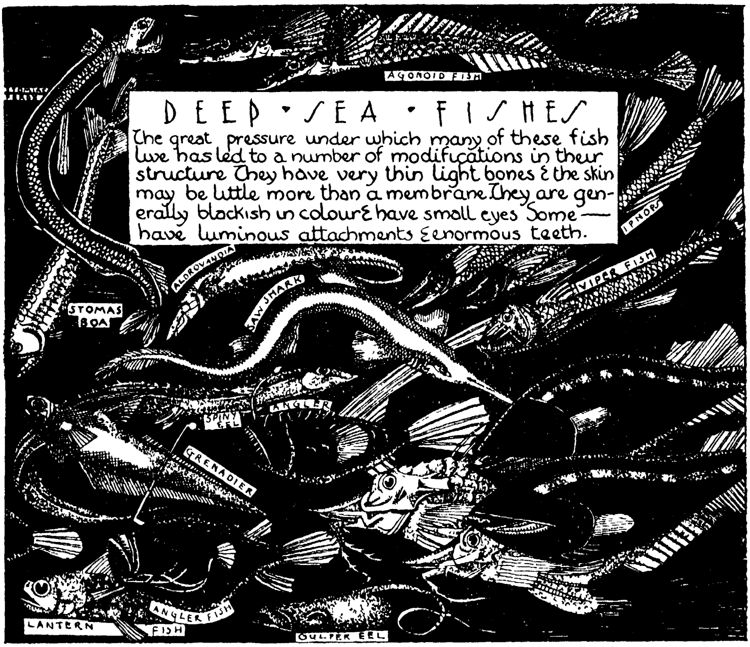
High and low tide are not at the same time every day, owing to the fact that the moon is passed about 50 minutes later each day by any spot on the globe. This is because, while the earth is wheeling round on its axis, the moon is moving in the same direction round the centre of the " pull " between them, and the moon, travelling somewhat slower, loses twenty minutes or so each day.

This action of the tides, flowing and ebbing twice a day, is like the movement of a mechanical cradle, rocked by a machine that has been set in motion from eternity to perform its regular motions for all time. This being so, living forms have come to know what to expect, and have adapted their bodies and their habits of life to the daily happenings outside them, which never fail. In the words of the scientists, creatures have adapted themselves to their environment.

The shore is one of the roughest, most varying environments upon earth. The creatures who dwell there are mostly sea creatures ; yet twice a day the sea deserts them and leaves them upon dry land. When the tide is low, there may come heavy storms of rain, and instead of the salt sea environment in which they are at home, the sand may be soaked by fresh water from the skies, and the salt sea-pools may become almost as fresh as inland duckponds. At low tide on a hot summer's day, a gale of wind may spring up and drive clouds of fine sand before it : such sandstorms are to the beach creatures as perilous as a sandstorm in the Sahara is to a caravan of human travellers.

In this savage environment it is not too difficult for us to imagine forms of life adapting themselves, not only to life on the beach in an endless variety of ways, a few of which we have glimpsed in the last Book, but also to life in more stable environments. Creatures, in fact, were driven from the shore to seek peace in the depths of the sea, and amid the high lights of the dry land.

We have watched the adventurous lives of the salmon




and the eel. They are creatures whose habits echo the restlessness of the seashore : they outdo the tides in their vast coming and going. The eels that know the depths of the ocean have as their companions in those dark places the creatures of the *Abyss* and the great *Deeps*.

Although to-day hundreds of thousands of kinds of creatures live on what we call " dry land," no living thing has ever quite escaped from the sea. The " dry land " on which we live is in reality soaked by the sea.

The waters of the sea are drawn up by the heat of the sun to form clouds, which are driven over the land by the wind. The clouds fall as rain to form springs and brooks and rivers, which flow again into the sea. All water comes from the sea and flows again into the sea.

Where this tide from the sea does not reach, there is no life. All living things depend upon water, and, indeed, they

are built up very largely of water. The human body is nine parts water. The water within our veins and arteries, the "blood serum," is almost exactly like salt sea-water.

Human beings are very like the fish of the sea. We breathe like fish ; for, although we would drown if we were under the sea for more than two or three minutes, every breath we take enters our body through a film of salt water within us, almost exactly as the air enters a fish through the gills.

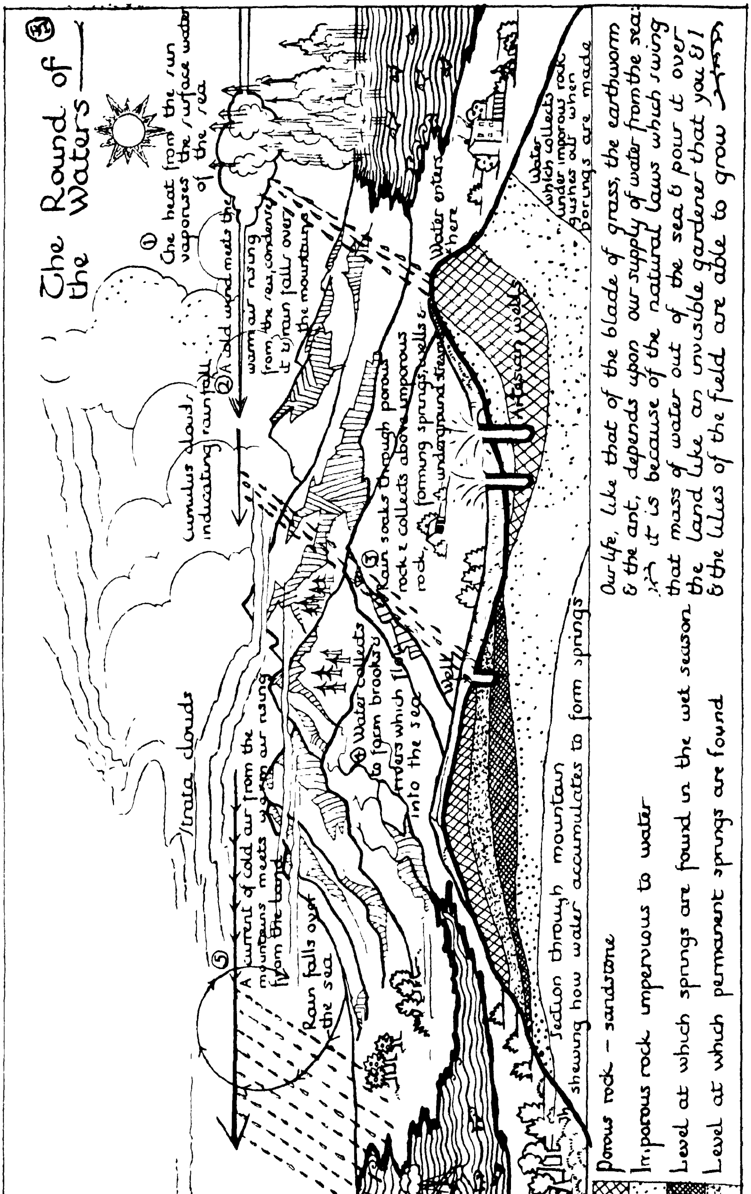
All animals on the "dry land" breathe through salt water in this way ; so we can say that we carry some of the sea about inside us in order to remain alive. All plants upon earth are dependent upon water in much the same way. They take up food from the soil through their roots in *solution* : that is, in liquid form, dissolved in water.

Our life, like that of the blade of grass, the earthworm, and the ant, depends upon our supply of water from the sea. It is because of the natural laws which swing a mass of water out of the sea and pour it over the land, like an invisible gardener, that you and I and the lilies of the field are enabled to grow.

There is another element which brings the sea creatures and the land creatures into close affinity with one another. Even as land creatures carry some of the sea about inside them in order to keep alive, so do the sea creatures carry about inside them some of the atmosphere in order to keep alive. All living things must breathe oxygen, in the manner at which we have looked in Chapter III of the last Book.

Water and oxygen are the two prime necessities of life. The sea is well "aerated" and the air in the sea is much richer in oxygen than is the atmosphere which hangs over sea and land. The atmosphere which we breathe is a very complicated medium for life, and is well worth a few moments' notice, since we are now going to view the land-plants and land-animals that live in it.

People talk of things as being "as light as air" ; but we have seen that air is strong enough to hold up the sea-birds who glide for hours with outspread wings.


The Round of the Waters
31
① The heat from the sun vaporises the surface water of the sea
② A cold wind meets the warm air rising from the sea, condenses it & rain falls over the mountains
Cumulus clouds, indicating rainfall
Strata clouds
⑤ A current of cold air from the mountains meets warm air rising from the land
Rain falls over the sea
④ Water collects to form brooks & rivers which flow into the sea
③ Rain soaks through porous rock & collects above impervious rock, forming springs, wells & underground streams
Water enters here
Artesian well
Well
Water which collects under impervious rock gushes out when borings are made
Section through mountain shewing how water accumulates to form springs
Porous rock – sandstone
Impervious rock impervious to water
Level at which springs are found in the wet season
Level at which permanent springs are found
Our life, like that of the blade of grass, the earthworm & the ant, depends upon our supply of water from the sea: it is because of the natural laws which swing that mass of water out of the sea & pour it over the land like an invisible gardener that you & I & the lilies of the field are able to grow

Air, then, like water, has weight. It is actually as heavy as a ton to the square foot and would crush us as easily as a submarine torpedo-boat would be crushed in the eels' nursery, if our bodies were not adapted to bear the weight.

The atmosphere of our earth may first be looked upon as a heavy overcoat worn to ward off the intense heat of the sun in the day, and to protect us from the intense cold of space at night. The moon is foolish enough not to wear this overcoat, and consequently under the blaze of the sun she nearly reaches boiling-point ; yet during an eclipse of the moon, when earth cuts off the light of the sun from the moon's face, in one hour the almost-boiling moon cools down so that *there is not the slightest trace of warmth* anywhere on her. In one hour, from being nearly at boiling-point, she has gone *stone cold.* Without the overcoat of atmosphere the same thing would happen to the earth. All living things would be destroyed by day, scorched to death in the blaze of the pitiless sun ; only, they would not have survived until sunrise, for by night they would have been frozen solid. No living thing could, of course, be born upon such an earth.

Keeping us warm at night, keeping us cool by day, are by no means the only good deeds of the atmosphere. If there were no atmosphere there would be utter silence over all the earth. The very volcanoes would belch forth their lava without so much sound as a bee makes breathing. Not only that. Without the atmosphere, there would be no daylight. Even during the blaze of midday, the white sun would pour his consuming rays upon us out of a blackness as of the darkest night. . . .

And there is one thing more should make us glad we have the weight of the atmosphere to carry upon our shoulders ; for the atmosphere, as we have seen, contains oxygen, the air we breathe into our blood, the air that our blood carries to every part of our body to supply the energy of life to our myriad cells.

There is more than three times as much nitrogen as oxygen in the atmosphere, but it is oxygen on which our life solely depends. In an atmosphere of pure nitrogen we should suffocate. In an atmosphere of pure oxygen we

should live a great deal too fast : the fires of our life would burn out in a very short time.

As it is, we breathe a weak mixture of oxygen, nitrogen and other gases, obtaining just enough oxygen to get along comfortably. The other gases in the atmosphere include the elements hydrogen, helium, argon, neon, krypton and xenon ; and several compounds, the most important of which are water vapour and carbon dioxide.

We do not often realise how the whole atmosphere is saturated with *invisible water.* We are all familiar with clouds in the sky, and the dullest of us are sometimes caught by their beauty. But there is far more invisible water in the atmosphere than there is visible water in the clouds ; and it is this invisible water which, more than any other agent, is responsible for the temperature of the earth. The water vapour, in fact, is the warm lining in the atmosphere overcoat, since water is a good *conductor of heat.*

The other compound, carbon dioxide, is made when certain things *burn* : we have seen that it is made when the fire of life burns. The fire of life burns too slowly for *flame* to be produced, but it is a true burning nevertheless. We have seen that when we breathe in oxygen, every molecule of oxygen unites in the molecule of our protoplasm to form a molecule of carbon dioxide : this union is the chemical change that creates the energy of life ; and the used-up carbon dioxide has to be expelled : that is, it is the carbon dioxide which is *breathed out.* Breathing out is like the action in the exhaust pipe of an automobile. Carbon dioxide is like the fumes puffed out of the exhaust. All sorts of burning substances pour carbon dioxide into the air, and there is always about the same amount of this compound in the atmosphere.

These two compounds, and the other gas elements we have mentioned, float about together in the atmosphere. They make up the atmosphere ; but they do not make it a compound. A compound is a new whole produced through chemical change in the elements composing it. Carbon dioxide is a compound of oxygen and carbon which can only

be produced by several forms of burning. The atmosphere, as a whole, is not a compound like this. The atmosphere is simply a mixture of all the gases it contains, like a pile of assorted sweets on a confectioner's shelf: only, of course, each different kind of " sweet " in the atmosphere is a molecule of a different gas—and remember how small a molecule is!

There are about 75,000,000 molecules of the atmosphere gases in a line one inch long.

It is because of this *molecular* nature of the atmosphere that living creatures are able to hear sounds. Sounds are produced by waves that travel through the myriad molecules of our atmosphere. These waves may be started, for example, by a plucked string that shakes to and fro and sends out waves through the close-packed atmosphere-molecules in the same way as a stone dropped into a pool of water sends out waves through the water. In a pool, the waves sent out by a dropped stone may cause reeds upon a bank to shake to and fro—one wave, one shake. In the same way the sound-waves from a plucked string, beating against the mechanism of your ear, cause the nerves within your ear to shake—one wave, one shake: which means that your ear-nerves *vibrate* at just the same rate as the plucked string. Your ear-nerves pass on these vibrations to your brain, and you hear what you call the sound of the string being plucked.

We may say with some truth that there would be no sounds in the world if there were no ears to hear them. Yet there would be the waves, the vibrations, rushing soundlessly through the molecules of the atmosphere.

It is hard for us to realise that these sound-waves in the atmosphere are actual physical waves, as real as the sea-waves that pound upon the sandy beach and burst among the rocks. Indeed, each sea-wave that breaks with a roar sends to our ears many hundreds of sound-waves. These sound-waves all have crests and troughs, just like the waves of the sea. The distance between one wave-crest and the next is known as the wave-length and is a very important thing in the world of nature. For the lowest note of the

piano the wave-length is several feet. For the highest note of the piano it is only one or two inches.

Sound is by no means the only thing which reaches us in invisible waves. All *light* and all *heat* reach us as waves sent out from some distant object in much the same way as sound is sent out from a plucked string. The blaze of the sun, like the glow of a candle, is caused by the shaking of certain kinds of atoms and molecules that send out waves that our eyes register as *light*.

The waves of light travel at an amazing speed and never slacken that speed so long as they remain light-waves. They can circle the earth seven times during one beat of the human pulse. Their rate is 186,200 miles per second. Professor Einstein has shown that it is impossible, in the nature of things, for any material body to move faster than the speed of light. We cannot begin to imagine such a speed; but we must hold fast to the fact that this streaming light seems to move in waves through the ether in almost exactly the same way as does sound through the air. Indeed, there are even different wave-lengths of light.

In the same way as our ears resolve different sound-waves into different notes, so our eyes resolve different light-waves into different colours. The longest light-waves that we can see produce in our eyes the sensation we call *red*, the shortest light-waves that we can see produce in us the sensation we call *blue*.

Imagine the uncountable waves of light entering earth's overcoat of atmosphere from the sun. The millions of molecules of atmosphere-gases get considerably shaken up by this surging tide of light-waves from the sun. Some of the light-waves with the shortest length get knocked out of place. These short light-waves are those which produce in our eyes the sensation we call blue ; and these blue waves get scattered through the gases of our atmosphere and shine among the molecules.[1] This is the reason for our *blue sky*, which shines upon us and gives us that daylight which no man in the moon would ever experience.

[1] Colour that is seen because certain light-waves have been scattered, and therefore shine upon certain substances, is called *refracted* light : from Latin for " broken up " (*refractus*).

When the atmosphere is heavily charged with rain-clouds or with dust and smoke, not only the blue wave-lengths, but the wave-lengths of all colours, get scattered, and then they produce in our eyes the impression of *whiteness*.

Now, this vast story of the sun-waves lets us into various secrets. We can see that the waves of light can be stopped and turned aside. Different wave-lengths can be turned aside at different times by different things ; and this is, indeed, the way in which all colours on earth are produced.

Little would you dream that the green of the grass and the trees, the colours of the flowers, the yellow, red, mauve, purple and blue of the daffodils, poppies, wild vetch, violets and cornflowers, are no more qualities of these flowers than the cough of the radio announcer is a part of your receiving set. The brilliant yellow of the buttercups, for instance, is being " received," moment by moment, across 92,000,000 miles of space from the sun.

It happens like this : certain cells have the power of catching certain wave-lengths of light. Instead of knocking certain light-waves aside, as happens to the blue waves in the sky, these cells soak up certain light-waves altogether. Actually, they catch certain light-waves and slow them down into heat-waves so that they are seen no more. These cells do not catch *all* the light-waves ; and those they do *not* catch are reflected and are seen by us as colours, according to their wave-length. The cells which capture certain light-waves, and reflect other light-waves, are called *pigment cells*.[1]

For example, the petals of the poppy contain pigment cells that catch, or *absorb*, all the light-waves except the long red ones : the long red ones stream back from the poppy petals, so that our eyes see the poppy petals as red. A lily is white because it reflects all the rays of the sunbeam, as do snowflakes. The petals of the daffodil absorb all the wave-lengths of light except yellow : the yellow rays are sent back and we see a yellow flower.

Some people are *colour-blind*. That merely means their eyes

[1] Colour that is seen because certain light-waves have been lost, and only those seen remain, is not refracted light but pigment light.

cannot receive or their brains cannot interpret the various wave-lengths that give the sensation of colour.

If we recall for a moment that French professor's experiments with soft lumps of putty in the water (Chapter IV, Book One) we may be in a better position to grasp the evolution of such things as eyes and ears. In some respects there is a sameness between the development of the shapes of fishes and the development of eyes and ears. In one aspect, shapes and eyes and ears are all caused by movements from without, coming upon living creatures. But of course we can imagine dead things, like the rocks of the coast, taking shape from the beating waves of the sea, whereas the coming of eyes and ears in response to the beating of light-waves and sound-waves is a conscious and purposeful thing.

All living beings feel the beating of light-waves upon them. Even the plants, as we shall shortly see, are covered with minute eyes. The lowest animals, too, are conscious of the difference between light and darkness. The sea anemone will wince if we reflect the sun's rays upon him. The delicate light-spots of the lancelet are yet more sensitive than the cells of the anemone : they are the tips of special nerve-cells that are, as it were, drawn out in response to those waves through the ether.

In the higher animals the eye is fully developed. At first an eye is simply a long, stalked nerve which grows out from the brain to the surface of the skin, where the light-waves play most heavily. The outer end of this nerve swells into a globe. The skin in front of this globe becomes altered so as to form a part of the globe itself. This globe is the young eye. At first it is not a much better arrangement than the sensitive spots on a lancelet ; but as the eye grows by cell-division, the cells take on the shape and power of lenses of crystalline clearness, and the eye becomes able to receive all that the light-waves bring to it—all the colours and lights and shades brought by a great number of wave-lengths. The eye carries forward to the brain all the messages of the outer world conveyed by the light-waves.

In a similar way to that in which the eye has developed in

response to the waves of light, the ear has developed in response to the waves of sound. We have no space in this book to explore the marvels of the ear ; but let us recall finally the true nature of a *wave*.

When you shake a whip, none of the whip travels forward. The only things that travel are the forms of the shake. When you drop a stone into a pool and waves travel out to the sides of the pool, no *water* moves forward with the waves. The only things that move are the forms of the waves. In the same way with sound-waves : nothing material travels from the plucked string to your ear—only the molecules beside the string are pushed, and this push travels to the molecules that are already beside your ear and shakes them in the way that the string shook, and you hear the sound. This seems also to be the case with light, though it is not quite certain whether real scraps of electric force (bunches of molecules) travel as light.

The point, however, is this : that by this mysterious movement of *nothing but form* through *something physical*, ears can hear things at a distance, eyes can see things far away, and living creatures have evolved ears and eyes so as to come into contact with much of the earth and the universe that is too far away for them to touch. Thus can men and all animals see where they are going : they can hear their enemies : and can plan their movements in life purposefully.

These facts serve to remind us how close a relationship exists between living creatures and their environment. Living things may be said to be bundles of adaptations to environments. The seashore we have called the cradle of life ; the whole earth is now the home of living things.

In response to the beating of light-waves living things have evolved eyes that see light-waves as colours. They have evolved ears that can hear certain waves through the atmosphere as *sounds*. They have evolved organs which can take in gulps of oxygen from the atmosphere to sustain them through days of toil and play ; and organs to take in fuel for the fire of their lives. They have made themselves muscles to move about, in order to conquer and explore the

earth ; so that we can say they have made the earth their home. . . .

It is important to remember that the waves and forces of the outside world, by acting upon living beings, do not produce organs such as eyes and ears and muscles. The creation of living beings, with all their powers, is a process of which we know little or nothing. We do not know how life began upon the earth. We do not know how the many races of creatures came about. We know only a little about the way in which parents of all kinds reproduce in their children the special forms and characters of the species to which they belong. The work of Gregor Mendel (1822–1884) began to show us how such characters are passed on from generation to generation through special tiny bodies in the nuclei of the sperm cells and the ova cells. When these two sorts of cells join to make one cell, as we saw on page 42, a new creature is begun ; a creature not *quite like* either parent, but a creature carrying on the form and character of the species.

By examining the forms of extinct animals preserved as *fossils* in ancient rocks we have been able to trace back the history of many species. These rocks are of different ages, and the fossils in each age are different and these differences in the forms of the same species of creature have shown the changes that have taken place in that species throughout vast periods of time. By this means we have traced back the history of many species in each phylum to different and often to simpler forms that lived in the past. But at the time of the oldest fossils *all the phyla of creatures already existed*, and so we cannot trace how the phyla arose from a simple beginning, nor can we be certain that all phyla did spring from the same sort of creature at the start.

And so, although we have said that all creatures on earth may have sprung from one-celled forms of life in the beginning, we do not know this for certain. Here and there we find many hints that the phyla are all related, and it seems most probable, for many reasons, that all life had a single-celled beginning.

# Book Two

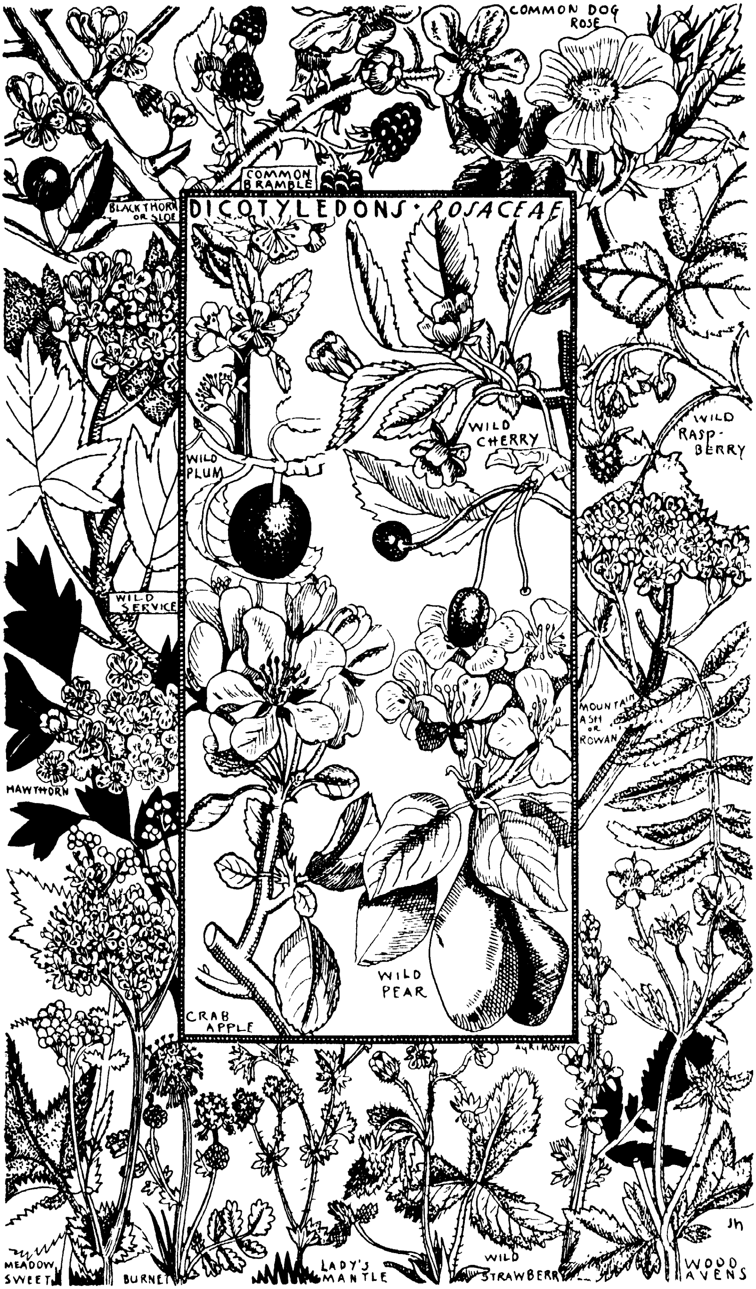
# An Outline of the Plant World

There's enough mystery left in flowers to tax the intelligence of man for many generations to come. In this Book, which is a concise botany, we not only describe a great number of the common flowers, shrubs, trees, grasses and other forms of plant life : we also view the vegetable world as a whole in relation to the other realms of nature, including man, and see its importance in evolution. Among the subjects treated fully in this Book are :

- Soil-making
- The earthworm
- The anatomy of a tree
- The plant families
- Fungi
- Parasites
- Bacteria
- Lichens and mosses
- Ferns
- Coniferous trees
- The economy of a forest
- Functions and evolution of flowers
- Insects and flowers
- Reeds and rushes
- The first living thing on earth

Descriptions of flowers and trees include the members of the following families: Lily, Arum, Rose, Iris, Amaryllis, Oak, Chestnut, Willow, Olive, Pea and Bean (Leguminous), Elm, Lime, Maple, Plane, Elder, Nightshade, Rose, Heath, Box, Walnut, Holly, Magnolia, Tamarisk, Buttercup, Daisy.

Many of the above families contain scores of species, a great number of which are fully described in this Book.


COMMON DOG ROSE
COMMON BRAMBLE
BLACKTHORN OR SLOE
DICOTYLEDONS · ROSACEAE
WILD CHERRY
WILD PLUM
WILD RASP-BERRY
WILD SERVICE
MOUNTAIN ASH OR ROWAN
HAWTHORN
WILD PEAR
CRAB APPLE
AGRIMONY
MEADOW SWEET
BURNET
LADY'S MANTLE
WILD STRAWBERRY
WOOD AVENS
JH

# CHAPTER I

# THE TWO WORLDS OF THE PLANT

IF STRANGE LIVING BEINGS were discovered on another world, high up in the heavens, we should all be thrilled beyond measure to learn of their forms and ways of life. Yet under our noses there exists a world at least as wonderful as any world among the stars. Although so close to us, this marvellous world is known to but a few among us ; and even those few would know nothing of it if certain men had not had the wit to turn from sky-gazing to earth-gazing.

Plato said there was no other beginning of learning than wonder. A man, like a monkey, sees a strange, beautiful thing, and is filled with wonder ; and the man, like the monkey, proceeds to examine the wonderful thing ; but, unlike the money, the man at length succeeds in discovering at least some of its secrets, and then, again like the monkey, the man's wonder ceases, and he takes the wonderful thing for granted.

Children are filled with delight at the wonder and beauty of flowers ; but if they are lucky enough to be able, when they grow up, to pursue the object of their wonder through the botanical schools and museums, they sometimes become like the man in the rhyme :

*Primroses by the river's brim*
*Dicotyledons are to him,*
*And they are nothing more.*

Yet a primrose, and for that matter any plant, is a more weird and mysterious monster than any which a writer of fiction has invented to inhabit another planet or a distant star.

The plant lives in two worlds, each as unlike the world of men as any possible inhabited star or planet in the skies. The roots of the plant dwell in the soil, which is a world full of the strangest beings. The branches of the plant dwell in the upper world of the sun's rays and the atmosphere-gases. In this upper world the plant performs a great marvel.

Plants are the only forms of life that *do not eat living things.* There are, it is true, some plants that eat insects, others that eat birds and mammals ; but these plants are exceptions, variations from the true plant-form. The plant-form takes into its body atoms of energy and molecules of sustenance from such dead things as the minerals in the soil and the carbon dioxide in the atmosphere.

This is the real difference between animals and plants : that animals eat living food, the cells of animals digesting cells as like themselves as possible; whilst plants make their food out of dead and simple materials.

An animal, in order to go on living, has to destroy other living creatures and turn them into new parts of himself. A plant, in order to go on living, spreads out its arms to the sunlight and the air, and spreads out its roots in the soil, and from the gases in the air and from the minerals in the soil it builds up its own living body : in order to perform this mighty miracle, the plant catches and uses the energy of the sun's light and heat.

Because of this fact it is believed that the simplest possible plant was the first form of life to appear upon the earth. The simplest plants in the world to-day are the one-celled plants like the diatoms, which the amoebae eat.

The diatoms which live in their millions in the seas and ponds and rivers of the world to-day, are complicated and beautiful plants, though they are so small as to be invisible

save through a microscope. They bear upon themselves the marks of ages of change and progress, and the first one-celled plant on earth must have been very different from the diatom of to-day.

There are many thousands of species of diatom in the world to-day. An American professor states that over 8,000 species have been identified. Like the one-celled animals called foraminifera the one-celled plants called diatoms make a sort of shell around them, though it is a transparent shell, like a glasshouse, through which the sun can shine. These shells are like minute greenhouses in which the plants float in the water. The shells are made of silica, and are thin enough for the salts and acids in the sea to soak through. The shells of diatoms are in two parts, fitted together, like a box and a lid.

Like the amoebae, the diatoms have young by splitting in half; and in the same way as millions of generations of foraminifera and their relatives have left behind them vast cliffs and mountains and countrysides of chalk and limestone, so the old shells of millions of millions of diatoms have formed great areas of the earth. The remains of diatom shells make up great cliffs in California, at Richmond, Virginia, and in many other places all over the world.

Many species of diatom are beautifully coloured and shaped, and lined in exquisite patterns; and diatoms are by no means the only one-celled plants on earth: there are thousand other kinds of one-celled plants, many of these, again, being gloriously beautiful, like tiny jewels or coloured crystals of fantastic shapes. The forerunner of these tiny, lovely creatures may have been the spark which lit the fire of life on earth.

However that may be, certain it is that to-day all life on earth depends upon plants. Animals, left to themselves, would soon destroy one another; but all the while that animals are hunting and killing, plants are silently creating life where there was no life.

In the beginning of plants, as in the beginning of animals,

we must picture the one-celled plants clinging together in *organisations*. We have already seen that the seaweed called bladder-wrack has different cells that act almost like the organs of an animal : more especially we watched the sperm cells and the egg cells meeting and making a new bladder-wrack. The bladder-wrack is as far advanced beyond the first one-celled plant as the lancelet is advanced beyond the first kind of amoeba.

There were seaweeds that were half-way between being sea-plants and land-plants ; and the story of the coming of the plants from the sea to the " dry land " is one of the most fascinating in the history of nature. For, in the conquest of the earth, plants are the pioneers, and all other forms of life are but camp-followers.

In following the journey of sea-plants on to the land we must get out of our heads the idea that plants are quite *unmoving* creatures. Anyone who has seen a " speeded-up " cinematograph film of the growth of a plant, in which the growth of many months is seen taking place in a few seconds, will have marvelled at the animal-like way in which the roots beneath the soil seem to feel about for the best direction in which to grow, avoiding stones and other obstacles, nosing into the soft damp soil like burrowing animals. At the other end of the plant, too, the end that grows up into the sunlight, the speeded-up film can show how like a sensitive hand is the tip of the main stem of a climbing plant. It waves in the air until it can coil round something : if it slips off it coils again : sometimes it will circle round and round in the air quite wildly, seeking a handrail by which to climb up towards the sun.

If we can feel that plants are *moving* forms of life, we can picture their progress in the course of ages from the sea-bed to the bed of soil in our gardens.

The soil of the earth has provided the soft warm bed in which the plants flourish. Without soil, the earth would not possess her covering of green plants ; and therefore without soil there would be no land-animals, no birds, no beasts and no men.

In the beginning there was no soil. Soils have been made in two ways.

In the first way, rainwater fills up the cracks and crannies of the inland rocks. When this water freezes in winter it expands with a force that rends the rocks apart. While the frost lasts the slabs of rock thus split asunder may stay in position, but they often fall when the thaw comes.

We have unpleasant experience of this power when water freezes in our houses, expanding and cracking the water-pipes. When the thaw comes, water may pour in torrents from many unexpected leaks. In this case water bursts lead and iron piping ; which perhaps may prepare us to understand how water can burst rocks.

Year after year, as thaw follows frost, this breaking up of rocks continues. Gradually over many barren rocky lands the whole face of the country crumbles and decays. The rainstorms of summer, the winds and the running streams, all aid in this breaking up of rocks, and great areas of the earth after long ages become covered with a layer of powdered rock. This we call *soil.*

In the making of soil, plants have themselves played a part, but we shall look at this second way of soil-making in our next chapter.

For countless ages this soil has lain like a thin skin over parts of the rock-surface of our earth ; and the soil has become the home of myriads of strange creatures.

Of the creatures in the soil by far the most numerous and important are the germs, or *bacteria*, though we must deal with them in a later chapter. The bacteria were discovered by Antony Van Leeuwenhoek,[1] the Dutch scientist, who called them "animalcule," "little animals," though, as it has turned out, bacteria are mysterious creatures that may be neither plants nor animals. The bacteria are one-celled creatures, nearly all of them being far smaller than amoebae and diatoms. In the upper few inches of the soil, a cubic inch would probably contain 400 million bacteria.

Next to the one-celled creatures in the soil, in numbers

[1] 1632–1723.

and importance, are the earthworms. It has been said that if a bacterium were the size of a pin's head, an earthworm would be as big as a tube train, and would travel through his burrow about as swiftly as the train through the tunnel.

There are often nearly a million worms at work in an acre of good soil. Even a poor soil will probably support a population of half a million earthworms per acre. When we speak of a " rich soil," we mean a soil that is rich in those minerals needed by plants for their growth, a soil in which water is held long enough for the plant to suck up the minerals in liquid form, a soil which is filled with enough air to enable the plant's roots to breathe.

In the making of a rich soil, the earthworms play a large part. That is their " work " in the world, and they do it by swallowing the soil in which they live, and casting it up on the surface, as we saw the fisherman's lob-worm doing to the sand of the beach, in Book One. So many earthworms are there in the soil, and so greedily do they swallow the soil, that every fragment of earth in the fields of the countryside, for two or three inches down, passes through their bodies once every two or three years.

The worms are nature's ploughmen, burrowing in their millions through the soil, so that it becomes " well aired," and so that its rich minerals are scattered evenly, in such a manner as most to benefit plant growth. The earthworms need air as much as the plant-roots do ; and they are like plants in that they *breathe all over them*, the oxygen filtering through their skin and the carbon dioxide filtering out. The worms are called " skin breathers." The scientific name for skin breathing is *cutaneous respiration.*

Because earthworms have no proper lungs with which to breathe, no eyes with which to see (though they can distinguish light from darkness), no ears with which to hear, let it not be thought that their long bodies are without organs. On the contrary, they have certain organs multiplied, it would seem, beyond reason : the common earthworm may have several hearts and numerous kidneys.

Among the really valuable organs of the earthworm are

certain *lime glands* which act upon the vegetable food from the soil (such as dead leaves which the worm swallows) and enrich it as plant food. In these, and other ways at which we have no time to look, those wriggling creatures beneath our feet are of immeasurable value to the whole living population of the " dry land."

For the soil is a strange factory. It is the place to which all dead bodies are consigned, where all dead bodies decay. Decay, as we shall see in Book Two, is only a sort of digestion. It is the digestion of those millions upon millions of bacteria who pull dead bodies to pieces, like invisible vultures, and break up dead flesh into its elements again.

A gruesome business, you think ? But no more gruesome than the famous legend of the phoenix who burned himself to death that his offspring might arise from his own ashes, a new phoenix stirring to the splendour of life from the glowing embers of the dead bird. In like manner, every little dead sparrow who falls to the ground, whose body is buried beneath the castings of earthworms, and taken to pieces by bacteria, is reduced again to the pure elements from which his body was in the beginning made ; and the elements that were in him join the stream of sap up the vast trunk of a tree, pouring out to the leaves, perhaps joining in making a berry which may be pecked by his son.

To the soil return the molecules of carbon, nitrogen compounds, and minerals, after their wanderings in the bodies of plants, in the bodies of insects and of other animals. In the soil they are smashed up and made again to start out on fresh adventures in new bodies.

To think of a less picturesque simile than that of the phoenix, the soil may be said to be like one of those scrap factories where old locomotives, old automobiles, old factory machinery, old steel ships, old iron of all sorts, goes to be melted down and turned out again as fresh bars of iron and steel, ready to be made into new up-to-date machinery.

This, then, is the first world in which the plant lives, the strange underworld of the soil. We have not glanced at

half the marvels it contains ; but we shall return to the soil before the end of this Book. We may, however, ask ourselves now :

Is a plant aware of the creatures of the soil in the way that a fish (even a blind fish) is aware of the other creatures in the sea ? It is hard for us to fancy a plant knowing about other living beings in the soil, although Charles Darwin believed that the questing root-tip of the plant was equal to the brain of some of the lower animals.

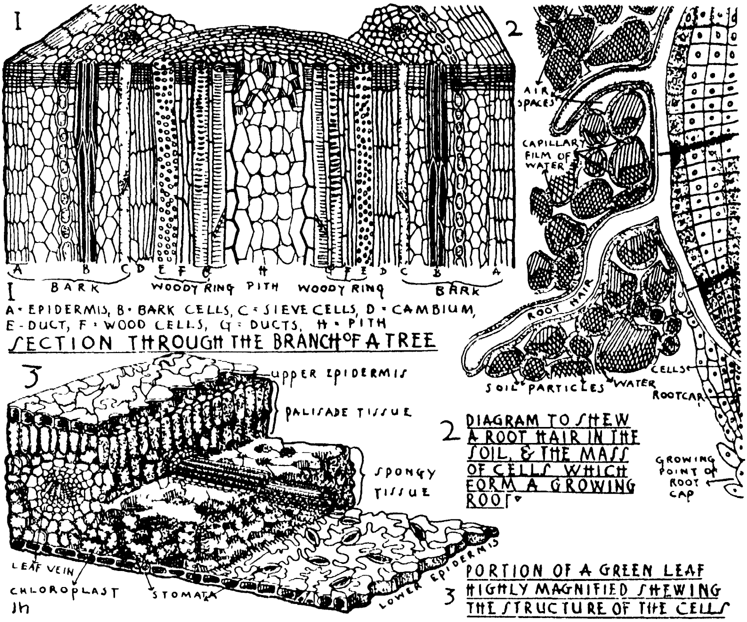
The tip of each growing root has a cap or shield of dead cells to protect the living cells from shock should the root-tip strike a stone or other hard object. Inside the root, behind this shield, is a hard little knot which acts like a brain to the root : if this knot, or " brain," is cut off, the root loses its power of finding its way round stones, and seeking out the richest food-soil.

From every root grow many *root hairs*. These root hairs are single cells stretched out into tubes as thin as threads. These root hairs grow wherever water lies round the powdery fragments of the soil, and they suck in this water.

Perhaps we should not say that plants " suck in " the soil-water, since actually the soil-water filters in through the thin tip of the root hairs by a mechanical process known as *capillary action*. This is a law of nature, like the law of gravity that draws water downhill. Capillary action is a law that makes a richer liquid draw a poorer liquid into it (or we might say it makes a *thicker* liquid draw a *thinner* liquid into it). The root hair is, of course, filled with rich plant-juice, so that the mineral-filled water in the soil, which is not so rich as the plant-juice, has to flow into the root-tip.

But note : we must not think that this capillary action is a dead process ; because the living plant controls the flow of water, and allows only water filled with minerals needed by the plant to flow in, and keeps out water holding poison or other harmful things.

Although the soil-water is thinner than plant-juice, it is rich in minerals. Floating about in it " in solution " are




such things as calcium, potassium, magnesium, phosphorus, sulphur, iron, nitrogen salts and other minerals. This mixture is constantly flowing up the insides of plants, through the stems, to the leaves. This soil-water flowing in plants is called *sap* ; and it flows up in different ways through different plants. Most of the more highly developed plants have a regular system of pipes, called a vascular system. This is made by tube-shaped cells through which the sap flows. The greater part of the trunk of a tree is made of cells that once were living but have died : the inner wood and the outer bark are dead. The living parts are the *sapwood*, which passes on the soil-water, the *cambium*, which is a layer of vigorous growing cells : it is the growth of the cambium cells, their ceaseless activity, which is the growth of the tree : this ceaseless activity causes the trunk to expand, which cracks the dead outer bark ; and inside the dead bark is the third layer of life, the cells of living bark.

When the sap reaches the leaves, the heat of the sun *evaporates* most of it : in other words, most of the water is turned into vapour which rises out of the millions of stomata in the leaves. It is said that a large birch-tree may send into the air through its leaves in one day eight pounds of water. A fully grown oak-tree sends into the air as vapour about 200 tons of water every summer. This sending out of water-vapour by trees and plants is called *transpiration.*

Now, what happens to all those rich minerals which have been hauled up out of the darkness under the ground into the sunlight ? They are not carried up in the water-vapour, neither are they left behind in the green leaves. They are used in the miracle of turning dead stuffs into living food.

In order that this task be performed the leaves have to get carbon dioxide out of the atmosphere and join this carbon dioxide to the minerals brought up in the water from the soil. The leaves do this through the energy provided by the sun's rays.

That amazing man Leonardo da Vinci was one of the first to see that the leaves of trees are not spread out haphazard on the branches. They are arranged in different patterns on different species of tree. On trees of the same species the pattern of the leaves is always the same.

These beautiful patterns of leaves, called " *leaf-mosaics,*" are designed so that no leaf shall shade another leaf. For the light of the sun, the bright daylight, is the life of the tree. And the green leaf is the part of the tree which is sensitive to the light. When lower branches fail to get the full daylight, they wither and die.

The outside cells of the top side of green leaves are like little eyes. They are crystalline lenses made of silicon. Photographs have actually been taken by means of these surface-cells of leaves. These cells are supposed to focus the sunlight to a spot on their opposite side.

Although this marvellous eye-surface extends over nearly the whole of the upper side of all leaves of trees and plants, it cannot with any truth be said that plants " see." The

work of these " eyes " seems to be to turn the light-waves into waves of heat. The power which is thus captured from the sun drives the machinery that makes living food for the plant out of dead minerals and carbon dioxide. In order for this to happen, carbon dioxide must be brought to the leaf, and joined to the minerals. The leaf itself draws in the carbon dioxide through its mouths.

As well as the eye-surface, there is, in certain parts of every green leaf, a multitude of little mouths, the *stomata.* The stomata cover only about 10 per cent of the average leaf-surface, but nature crowds these little mouths something like a million to the square inch. These mouths are mostly on the under-side of the leaf. It has been calculated that a fully grown sycamore-leaf may possess as many as 12 million stomata. A single leaf of a sunflower may have no less than 13 million stomata. Through all these stomata carbon dioxide is entering throughout the day.

When the carbon dioxide has entered, what happens in the leaf is this : each molecule of carbon dioxide is joined with a certain number of molecules of the water from the soil. Carbon dioxide is a compound made by two parts of oxygen mixed with one of carbon ; and when this gas from the air is joined within the leaf to the water from the soil, the molecules of the oxygen are taken from it and sent out through the stomata in transpiration. The carbon that remains is worked up with the minerals to form a new molecule of the type called a sugar.

All plants make a certain amount of sugar in this fashion, most of them afterwards forming starches out of the sugar. Sugars and starches are carbohydrates, which are good for food. In this way a plant makes its food out of dead matter. This process is called *photosynthesis*, which means " putting together by the power of light."

It is a wonderful operation, if we come to think of it. A certain gas is sucked out of the air by the leaves, certain minerals are sucked up into the air by the roots, through long tubes in the stems and trunks : the gas and the minerals are put together in the leaves, and are formed into sugars

and starches. Not until sugars and starches were made in living bodies could proteins be made, and not until sugars, starches and proteins were made in the bodies of plants could animals come to be. Animals must have sugars, starches and proteins in order to live, and since they cannot make these things for themselves they must depend upon plants for them. Thus, all life on earth depends upon this work in the green leaves of plants.

Now, the only things in the world which can supply the energy for this miracle are little green bodies in the cells of the leaves, which are called *chloroplasts*. These chloroplasts lie thickly beneath the eye-cells on the outer edge of the leaves ; and the sunlight, focused upon the eye-cells, passes through and is turned into energy by the chloroplasts beneath.

The green cells are called chloroplasts because they contain a substance called *chlorophyll*, which, next to protoplasm, is the most wonderful and mysterious substance in nature. It is the chlorophyll which catches the fiery light-waves of the sun, which have probably been focused for them by the " eye-cells," and this energy the chloroplasts turn to the work of making sugars and starches from carbon dioxide and the minerals in the water.

Once the sugars and starches are formed, the plant can begin to feed : and this food is carried back from the leaves to every part of the plant, in much the same manner as the blood-stream in an animal carries food to every part of the animal body, so that all the myriads of living cells which make up the body of the plant are fed by the flowing stream of food.

Everyone knows that plants help to freshen and purify the air we breathe. They do so simply by the process at which we have already looked, of making pure oxygen from " foul air " and breathing out pure oxygen through their stomata. Oxygen, remember, is the air needed to blow upon the fire of life in all living bodies, and this work of plants in breathing in the " foul air " (carbon dioxide), in separating the carbon and setting free the oxygen, is almost as

important for us and the animal realm as is their work of making food from air and soil-water.

Beside this process of food-making from gases and minerals, plants also breathe exactly as animals breathe, taking in oxygen and breathing out carbon dioxide ; but in plants this true breathing is a very much smaller affair than the big food-making process, and it is only at night, when there is no sun and the food-making process stops, that plants breathe out " foul air " only, as animals do. For this reason many people say it is unhealthy to have plants in a bedroom at night ; but a person or a pet dog or a lamp or a gas-jet would produce much more carbon dioxide in a room than would a plant ; and this in spite of the fact that plants breathe in and out *all over them*, and not only through their stomata. The stomata are used chiefly for the food-making process and they close up at night, while the whole surface of the plant is breathing all the time. Even the roots of the plant breathe, which is why there has to be plenty of air in the soil as well as plenty of water. The root hairs, as we have seen, have to suck up the minerals in the form of water ; but other parts of the roots have to be exposed to air in the fragments of soil, in order to breathe. If soil becomes water-logged so that there is no longer any air in it, the roots will be unable to breathe, and the whole plant will drown.

Now we may ask : Is the plant any more aware of the upper world of light and air than it is of the dark, hidden world of the soil ? We know full well that the world of the air teems with life that is seen and heard. Our ears are filled with the singing of the birds who make their homes in the branches of the trees, and we hear the gay and busy humming of the insects.

Through their flowers, plants seem to hold strange communion with the world of insect life. In this case it is hard for us to fancy that a plant does *not* know about the daily life and habits of its swarms of insect visitors.

People began to understand flowers only about the year 1793, when Christian Conrad Sprengel, Rector of Spandau,

near Berlin, Germany, published a very interesting book in which he showed how he had discovered that the beauty of flowers, their colour, shape, scent and honey, were by no means intended solely to decorate the world, like carved flowers on a church wall, which is the way in which most men had regarded these aspects of flowers up to that time.

It is true that men, even from ancient times, had known that flowers were the reproductive organs of plants. Aristotle had known that. So had Pliny. But why should flowers be so beautiful? Why should they have different colours? Why should they smell so sweetly? Why should they secrete delicious honey?

It remained for Sprengel to find out that these things were designed to attract insects to the flowers; and we can see to what extent flowering plants and insects live in communion if we briefly follow the history of flowers from the beginning.

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# CHAPTER II

# THE PLANT FAMILIES

THERE ARE about 233,000 different kinds of plant in the world. More than half of these are flowering plants (132,000 kinds), while 3,800 kinds are ferns. These hundreds of thousands of kinds of plant have been grouped into four great divisions.

(1) Thallus plants (Thallophyta)
(2) Mosses (Bryophyta)
(3) Ferns (Pteridophyta)
(4) Seed-bearing plants (Spermatophyta)

(1) **Thallophytes.** In this division of the plant kingdom are placed the seaweeds (*algae*) and the fungi. We have already dealt to some extent with seaweeds ; but we must here glance briefly at the fungi. Most of us are familiar with the fungi in the fleshy form of mushrooms, which so many of us have gathered, at one time and another, in the dewy fields, and of toadstools which cling on to tree-trunks and crop up in clumps in woodlands.

The fungi differ from all other plants in having no chlorophyll, and therefore they are unable to create life out of dead materials. They have to live on already living stuff, as animals do; but being created in plant-form, they are unable to move about as do animals in search of food, and they must fasten themselves on to other plants and suck up the food out of these other plants. That is why toadstools so often cling to trees, whilst those growing from the ground are really living upon decaying leaves or roots or other once-living substances.


Fungi, in short, are plants that feed like animals because they lack the power which is the great glory of plants—the power to capture the energy of the sun, and create out of dead gas and minerals new protoplasm for their cells. Those fungi that derive their nourishment from living plants or animals are called *parasites*. Those that feed on "dead" bodies are called *saprophytes*.

When we try to cultivate plants as crops, or raise flowers in our gardens, we must constantly fight against these other plants that live as parasites on the plants we try to grow. "Rust" on cereals, "smut" on corn, "blight" on pears, "scab" on apples, are tiny fungi, fixing themselves to these plants and sucking the strength out of them.

These fungi also cause in animals such diseases as anthrax, black-leg, foot-and-mouth, and chicken cholera. Among human diseases caused by fungi are cholera, diphtheria, lockjaw, pneumonia, tuberculosis and typhoid fever. Certain of these microscopic plants live normally in

the human ear ; some in the stomach, causing food to *ferment* instead of to digest ; some in the human skin, causing such diseases as ringworm.

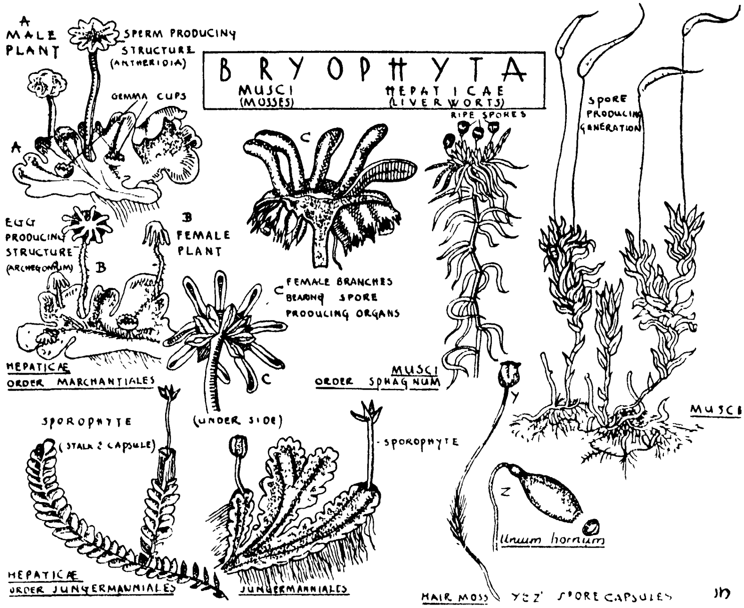
*Fermentation*, however, is an important and useful activity of the fungi. Like all one-celled creatures, these fungi multiply by dividing in half, each half growing into a new plant. Sometimes these microscopic creatures multiply at an incredible rate. One of the simplest of these fungi is the one-celled plant popularly known as yeast or leaven (from Latin *levis*, " light "), which is employed by brewers in the manufacture of the alcohol in their beer, and by bakers to make their dough " rise " by the creation of bubbles of carbon dioxide.

This fermentation of the yeast fungi is simply the multiplication of these tiny creatures at a terrific rate. Often four or five " buds " will grow out from one yeast plant, and break off to form new plants, in only a few seconds of time. This furious rate of growth causes them to use up a great amount of energy, so that they *breathe out* carbon dioxide rapidly, and this carbon dioxide forms bubbles over the growing mass of yeast.

Before we leave the thallophytes we must spend a moment or two with the lichens, which are extraordinary plants, being both fungi and true plants at one and the same time.

The common lichens which form the grey-green leafy coatings on the bark of trees, the yellow, red and black stains on palings, walls and rocks, and the flat or curly leaf-like growths on the ground, are made up of numerous fungi each of which surrounds a minute " seaweed." The " seaweed " part of lichens can hardly be called " seaweed " really, since it does not live in the sea ; but it is of the class *algae* to which the seaweeds belong. So perhaps we had better call it an alga.

The alga lives in a microscopic pool of salt water inside the fungus. The fungus supplies the alga with water and mineral salts, and the whole plant is so small and thin that the sun strikes through and gives the alga enough energy to live a normal seaweed life. In return for giving life and a




home to the alga, the alga provides food for the fungus, which sucks in food from the alga in the way that fungi have. The alga is never destroyed by the fungus, for that would be fatal to the fungus, who must keep the alga alive in order to obtain food. The living of two lives in one body for the mutual advantage of both, like that of fungus and alga in lichen, is called *symbiosis*.

(2) **Bryophytes.** This division contains all the mosses and liverworts.

We will look here only at the manner in which they reproduce their kind. On their tiny leaves grow two kinds of little sacs or cases, one kind containing sperms, the other kind containing ova. When rain soaks the plants, the sperms escape from their cases and swim into the ova cases, where they join with the ova. So small are some of these plant leaves and so close together are the sperm cases and the ova cases, that this swimming and joining can take place within a single raindrop !

Within the ovum case, sperm and ovum form into a spore. When dry weather comes, the ovum case (now the spore case) cracks open ; and when the wind blows, the spores are shaken out and blown away to other spots on mother earth, where they may stand a chance of growing into new plants.

The plants belonging to these two first divisions of the vegetable kingdom are among those that aid in the production of soil.

*The lichens, liverworts and mosses* spread over the face of *solid rocks*, like thin green coats. Many of these lowly plants live by dissolving out the minerals from the solid rock, as part of their food. Grains of dust from the air stick to these plants when the plants are damp. These grains soak through on to the rock, where they form a layer of mud or damp dust. When the lichens and mosses die and decay they crumble into a rich mixture with the dust, and upon this rich mixture their children flourish exceedingly. This is the beginning of a soil. A soil containing plant-remains supplies better plant-food than a soil which is pure powdered rock. And so, where dead plants lie over the rocks most thickly, living plants grow in the greatest numbers, and die there, deepening and enriching the blanket of soil.

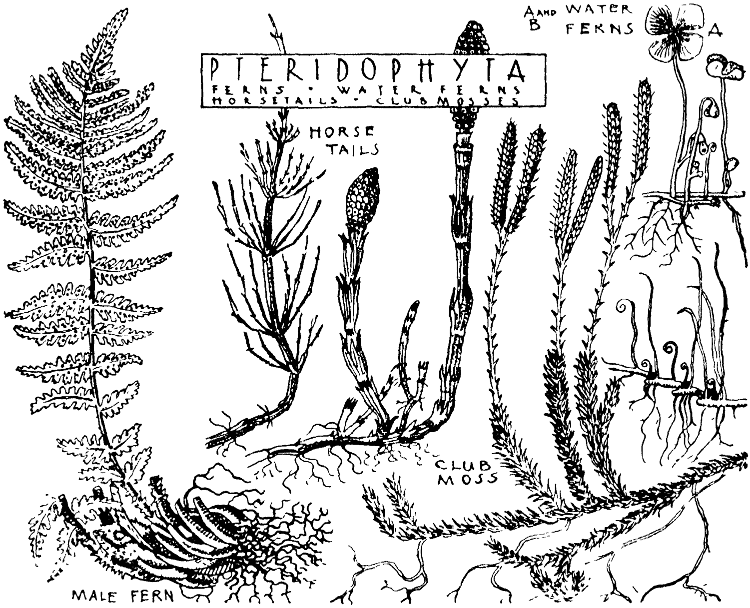
In this way, in the course of ages, soils formed without much breaking up of rocks ; and generation after generation of plants were growing up in the ever-deepening soil, into forests of noble trees, into flowering plants in a rich jungle.

The land-plants were helped in their evolution by the undiluted sunshine which they now obtained. The sunlight which reaches under-water plants is weak indeed by comparison with the full strength of the sunshine on land ; and sunshine is the life of the plant.

And so the plants moved forward over the land, eagerly footing it with their roots.

(3) **Pteridophytes.** In this division are all the ferns, club-mosses and horsetails.

When soil was formed over rocks, the first plants to




develop roots were ferns. The reproduction of ferns is a little more complicated than that of the liverworts and mosses. Ferns have true roots, and most of them stand up on their fibrous stems, and have branches. Some tropical ferns attain the height of trees. Ferns are amongst the earliest plants to have a system of tubes within them for the sap to flow up to the leaves, and for the food to flow down to the roots (vascular system).

On the under-side of the leaves or fronds of ferns you will notice masses of little knobs, so small as to give only a rough under-surface to the leaves. These are the spore cases, which grow out from the leaf without any joining of sperm and ovum. Each spore case contains a single cell, so small as to be almost invisible.

During hot dry weather these spore cases split open, allowing the spores to fall out and blow away. Thousands of spores may be blown off a single fern, like a cloud of fine dust. Some few of these spores may find a place on the ground where they can *germinate* (that is, *grow*).

The spores do not, surprisingly enough, grow into new ferns. They grow into quite other kinds of plants. They grow into tiny ground-creeping leaves very like liverworts or the simpler sorts of mosses ; and these tiny leaf-like plants will produce sperm cases and ovum cases which will join in wet weather in exactly the same way as the sperm and ovum of liverworts and mosses. From the fertilised ovum of this leaf-like plant, a new fern in time will grow. This is another form of alternation of generations, which we looked at in the case of sea firs on the sandy beach.

(4) **Spermatophytes.** This is the division containing the true flowering plants. When most people think of plants they think of spermatophytes. All the flowers of the garden and the wild belong to this division, as do the trees of the forest and the grasses of the meadow. This vast division of seed-bearing plants clothes the earth with colour and stocks it with animal food, so that we all may live. It is divided by botanists into two main groups :

GYMNOSPERMS (*Gymnospermae*). This group includes the conifers, or cone-bearers, which we shall examine in the next chapter ; and

ANGIOSPERMS (*Angiospermae*). This is the true flower-bearing group.

## CHAPTER III

# CONIFERS

THE FIRST "FLOWERS" may have been something like *cones*. The plants that bear cones are called *conifers*, "cone-bearers." Cones are clumsy wooden flowers. Like the sacs of bladder-wracks, liverworts and mosses, the cones of pines, firs and other *coniferous* trees are of two kinds, one kind bearing ova (*eggs*) and the other kind bearing *pollen*, which is the name given to the sperm-like powdery stuff in all the higher plants.

The pollen reaches the eggs by being blown in clouds from the pollen cones on one tree to the egg cones on another tree, or from the pollen cones to the egg cones on the same tree. This is a most wasteful manner of gaining the union of pollen with ova, since hundreds of thousands, perhaps millions, of little whirling pollen grains are dashed away on to the ground, where they die ; and only here and there does one grain of pollen (which is the sperm of the plant) land upon an ovum and fertilise it. Yet, in what other way could land-plants reach across to one another than by allowing the wind to carry the pollen between them ? This process is called *wind pollination* ; and most kinds of plants in the world have to rely in this way on the wind.

When pollen and ovum are joined they grow into a *seed*. That is to say, they grow into a miniature plant with a tiny stem and one or two leaves. Within the microscopic leaves of this minute plant is stored enough sugar and starch to feed the plant when it begins to grow, and around the whole plant forms a hard shell to protect it from the dangers

of the outer world. A *seed*, in fact, is *a complete young plant in a pot with a lid on!*

There is as great a difference between a poor naked spore and a well-protected finely developed seed as there is between a gypsy's baby left by the roadside and a rich man's son who is given a home and a college education. The spore is very often a single cell of life without a covering, sometimes with a frail coat; or perhaps a little bunch of cells with a thin protection. The spore is flung out into the world, an ungrown baby, to germinate as best it may. The seed, on the other hand, is already a full plant, and is started in life with food and a house of its own.

Which is not to say that ferns, mosses, liverworts and all spore-bearing plants are always poorer types than seed-bearers. For, as everyone knows, there are gypsies' sons who make good in the world and millionaires' sons who go to the bad; but the fact remains that we can see in the coming of seeds into the world a stage of progress in plant-life, an increase in the care of the young, and a growing command over the forces of nature.

The conifers are the greatest of the four divisions of gymnosperms, and they are divided into two main families, called *Pinaceae*, the Pine Family, and *Taxaceae*, the Yew Family. In these two families are 44 genera and 380 species of trees and shrubs. The leaves of nearly all conifers are what we call evergreen: that is to say, the trees are as fully covered with leaves during the winter as in the summer, and there is no season when all the leaves drop off. This does not mean that the leaves last as long as the tree. The usual life of an evergreen leaf is from two to six years. The leaves of evergreens fall singly from time to time, but new young leaves grow forth each spring and leave no bare gap in the foliage. When we speak of foliage we are apt to picture broad green leaves like those of the beech or chestnut. The leaves of conifers are for the most part very poor foliage. They are called "needle-leaves," because they are long and thin, often ending in a point: shrivelled, cold sort of leaves they look; but then those leaves are adapted to let

the wind through, and they are adapted to withstand cold, as many conifers grow in cold exposed positions. Most conifers are exceedingly beautiful trees, with a sort of sheer and stark beauty. The sap of many conifers is sticky and oily and strongly scented; from some species, resin, turpentine and forms of pitch are obtained. These products have been used by men since the dawn of history. The varnish that helped Egyptian mummies to resist the decay of centuries was made from the oil of turpentine that came from the sap of coniferous trees.

## PINE FAMILY

(*Pinaceae*)

**Scots Pine** (*Pinus sylvestris*). The smell of the pine-trees, the soughing of the wind in their boughs, the soft carpet of the fallen pine-needles underfoot, combine to make the pinewood like no other forest. " Flowers are few ; primroses are not here to be gathered, the bluebells prefer the beechwood ; the pinewood is the haunt of brambles, ferns and mosses and fungi. One season passes much like another ; there is no such succession of pictures as the oak-wood makes. The pinewood is always still, and its sole music may be that of the wind playing, as upon an instrument, among the infinite number of needle-like leaves, a music which has appealed to man through the ages : ' Sweet is the murmur of the wind among the pine-trees,' wrote Theocritus, above two thousand years ago."[1] One of the most beautiful of forest trees, the Scots Pine, often reaches a height of 100 to 120 feet—a spreading, mushroom-like tree, with a straight trunk and gnarled twisted boughs of fiery red bark. The shining green needle-leaves cluster thickly on the ends of the boughs. In May or June the air of the pine-forest is filled with the sulphur-like pollen as it blows away to reach the purple female flowers. The female cones seldom open and scatter their seeds until the third year after they have been pollinated. This Scots Pine

[1] Marcus Woodward, *The New Book of Trees*, p. 239.

is often popularly called Scots Fir. It may live to be more than 300 years old.

Coming somewhere within the huge family of pines is that curious tree popularly called Monkey-puzzle (*Araucaria imbricata*). It is a South American species, and forms large forests in Chile, especially in the province of Arauco, from which it gets its botanic name. This tree has long, dark green, glossy leaves, each ending in a sharp prickle : these leaves are of a leathery texture and are crowded together upon the branches. The tree is cultivated as an ornament in many parks and gardens in Europe and America.

**Fir** (*Abies pectinata*). The needle-like leaves of fir-trees are shorter than those of pines ; and in firs the leaves are set apart from one another, instead of growing in thick-set bunches, as in pines. The fir-leaves, also, are not stiff roundish spiky leaves, but flattish feathery ones, and although long and pointed, are altogether softer than those of their prickly cousins. And whereas pine-tree trunks will bend a little this way and that in their journey to the tip of the tree, the fir family insist upon a most unbending stem which rises like a pillar from the soil to the topmost twig. The cones of the firs stand up on the branches like temple towers.

There are about twenty-five species of true fir, of which the various kinds of silver fir are the family type. The silver fir of Europe is widely spread and is cultivated in America.

**Spruce** (*Picea excelsa*). The spruce very much resembles the fir in all things save in the fact that the leaves are not flat and feathery, but have four sides, with white markings on the four faces ; and the cones of spruce hang like bells from the branches. The branches of spruce tend to droop downward far more than do the branches of firs. There are about forty species of spruce. Being closely related to the firs, they are sometimes referred to as spruce firs.

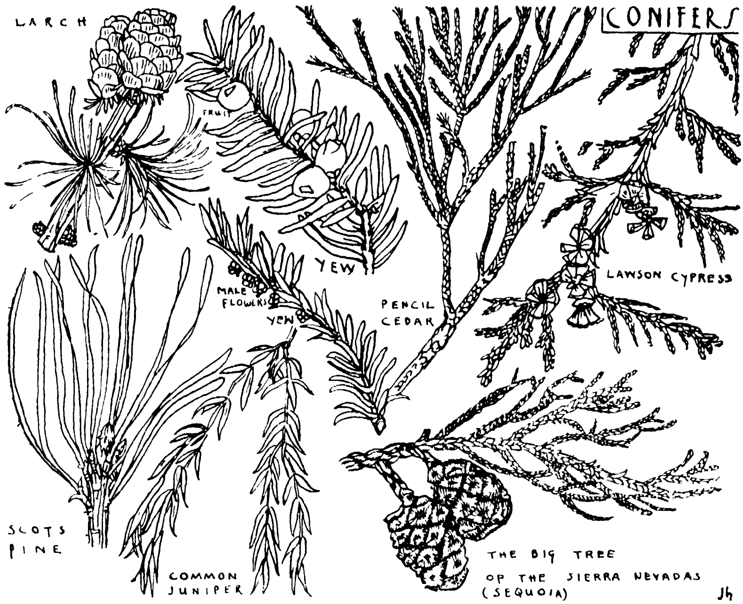
**Cedar** (*Cedrus libanotica*). The name cedar has been traced to its origin in the Arabic word *kedre*, which means

" power " ; and the majesty of the great spreading cedar, whose arms flow outward, whose great boughs sway their green foliage like a robe, has always been enough to inspire men with awe. The cedars of Lebanon are the family head, and to the Arabs these cedars were sacred trees. An Arabian poet describes them as bearing winter on their head, spring on their shoulders, autumn in their bosom, while summer plays about their feet.

The cedar does not aspire to be a tall tree. It sends its strength into its boughs, not into the trunk. At ten feet high, or even at six, an old cedar—and cedars can be very, very old—may be divided by a stupendous branch that holds its leaves but barely off the ground. Four or five of these great boughs, dividing off before the tree is 40 feet high, will leave little trunk to aspire skywards, and—though many ancient cedars on Lebanon may reach to more than 100 feet—70 feet, or even 60 feet, is a respectable height for a lawn cedar in a park in England. It is as a park tree, set on the green sward, that the cedar is best known in our land. The most stately groups of cedar in England, I suppose, are those at Goodwood in Sussex : it is certainly Goodwood I recall when I think of cedars ; but no, I best remember that first cousin to the cedar, the *deodar*, a lovely specimen of which grew outside my bedroom window in Oxfordshire in a small village where I lived as a boy. The deodar is the Himalayan cedar, and forms dense forests in the mountains of Afghanistan and northern India. It is the sacred tree of the Hindus, called " Devadera," the " Tree of God," the fragrant wood of which is burned as incense.

The " needle-leaves " of cedar grow in tufts, about thirty leaves to a tuft, and are about an inch long. The life of a leaf is from three to five years, the life of the cedar may be more than 1,000. The trees do not produce cones until they are about thirty years old, and seed and pollen may not appear in these cones until the cedar is 100 years old.

**Juniper** (*Juniperus communis*). The juniper is usually a small tree, scarcely more than a shrub, though sometimes




it may grow as high as twenty feet. There are about forty species of juniper found freely in many parts of the old world and the new. In the common juniper the leaves are spreading needles, though in some species the leaves are small overlapping green scales sticking by one face to the branches. Sometimes a juniper will have some branches covered with green scale leaves and other branches with upspringing needles. The male catkins of the juniper may be known in May by their numerous anthers and pale yellow pollen.[1] The female catkins will be found in the axils of the leaves, and look like buds. The juniper is unique among conifers in that the female catkin after fertilisation develops into a roundish green fruit called the juniper berry. These fruits take two years to ripen, and when ripe they may be purple-black or dark wine-red. Inside these fruits are the seeds which contain a valuable oil, " oil of juniper," which has a strong and curious flavour, and is of medicinal

[1] For definition of catkins, see Chapter VII.

value, besides being used in the making of gin : gin, indeed, gets its name from juniper, being a contraction of *genévrier*, the French for juniper. A beautiful little moth, *Hypsilophus marginellus*, is often seen upon the juniper, as its caterpillar feeds on juniper leaves.

**Cypress** (*Cupressus*). In the ancient world the cypress was the symbol of death, and by the Greeks of the classical age it was dedicated to Pluto, god of Hades, the unseen world of the dead. A splendid, gloomy tree is the common cypress of the south of Europe, and nowhere seen to better advantage than strung along the tomb avenue of the Appian Way outside Rome. The cypress is the churchyard tree of Greece and Rome ; yet if its tall straight dark green body is solemn in its beauty, it also has a certain liveliness about it, especially when it sways gracefully in the wind. For the cypress is not a heavy, weeping tree, like the yew ; but a tall, light, aspiring one, waving a feather-point at the sky. So, it makes the churchyards of southern Europe not *too* sad, not *too* solemn, and can dance among the graves without being frivolous.

There are about fifteen species of cypress, and many of these kinds resemble not in the least the straight tapering *Cupressus sempervirens*, the common cypress of Europe.

**Larch** (*Larix europea*). The larch is an exception among conifers, not being an evergreen. Every autumn they lose all their leaves, and grow a fresh crop next spring : they are therefore called *deciduous*, a word coming from the Latin " to fall."[1] The larch is naturally a tree of the mountains, a native of the Swiss and Bavarian Alps, and is planted a great deal in England, both as an ornamental tree, and as a " windbreak " to protect crops from gales.

**Sequoia** (*Sequoia gigantea* sometimes called *Sequoia Washingtoniana* and sometimes *Sequoia Wellingtoniana*). Also termed the Big Tree.

[1] The swamp cypress of America is also a deciduous conifer.

*A living thing,*
*Produced too slowly ever to decay,*
*Of form and aspect too magnificent*
*To be destroyed.*

WORDSWORTH.

Some of the sequoia trees are the largest living things on earth, reaching up 500 feet into the sky, with a girth about the tree-bole at the base of perhaps forty feet. Some of them are over two thousand years old, some over three thousand, and it is believed that some of them may be four thousand or five thousand years of age.

Men tell the age of a tree in the same way that they tell the age of a salmon. We examined the scale rings of the salmon in Book One, Chapter VII. Trees also have rings which tell their age and history. Because of the quick growth of trees in the spring, the cells of the sapwood are larger at that season than they are when autumn and winter set in; so that every spring the tree trunk grows larger and a round line or ring is left in the wood. When a tree is cut down, you can count these rings and tell how many springs a tree has lived through. Seventy-nine of the big trees that have been cut down had more than two thousand tree rings, four had more than three thousand; and the largest trees of all have not been cut, so the rings cannot be counted nor their age ascertained; but it seems certain that some of them are well over four thousand years of age.

Year after year the sequoias have been adding layer on layer to their girth in ever-widening circles. Age after age they have stood in silent grandeur on the slopes of the mountains of California. In some museums are shown cross-sections of sequoia with the annual rings marked at intervals, showing how thick the trunk was at the time of Christ, and at other outstanding dates. Some of the Californian trees were still in their youth and others were approaching middle age when the hordes of barbarians overran Europe and caused the downfall of the Roman Empire. They had almost reached their present height and girth and ripe old

age before modern science had begun to exercise its influence over the Western mind. They have lived, the big trees, since the days of Moses. . . .

There are but few of these most ancient and most gigantic trees. They live only in scattered groves on the western slopes of the Sierra Nevadas in California, at heights between 5,000 and 8,500 feet. A second species of sequoia, slightly smaller, is the redwood tree (*Sequoia sempervirens*). These trees are more widely scattered in thicker groves over the same mountain range. The height of redwoods ranges from 150 to 350 feet. A large redwood whose rings were counted by the Forest Service showed 1,373 rings ; and it is quite likely that a number of redwoods approach or even exceed the age of 2,000 years.

Both species of sequoia are evergreen with small leaves and small cones, the leaves of the big trees being more needle-like and less spreading than those of the redwoods. The cones are slightly larger on big trees, yet are very small for a tree of such proportions. Both species are covered with a great thickness of reddish fibrous bark—that of the redwood being a cinnamon red, and that of the big tree being lighter in colour.

Big tree and redwood are planted ornamentally in many parts of Britain.

We must leave this family of conifers with just a mention of the *arbor vitae*, and the *hemlock*, specimens of which are cultivated in our land.

## YEW FAMILY

(*Taxaceae*)

**Yew** (*Taxus baccata*). " The yew may be older than the Norman church it guards." Though young after sequoia, the yew probably grows to a greater age than any other tree in Britain. It is difficult to tell the age of a yew, on account of its annual rings being so close together ; for it is not one of your trees that climb up to an awesome height,

but, like the cedar, spreads out its strength in shade-giving boughs. It is the slowest growing of all trees, and its wood is the hardest and most durable. It is probable that 2,000 years is by no means an exceptional life-span for a healthy yew in a favourable situation. The yew has not the marvellous beauty of the cedar, but reveals its age and strength with a solemn dignity which has induced us to make it the churchyard tree of England, as the cypress is the churchyard tree of Italy and Greece. The reddish, deeply grooved trunk has the appearance of several trunks growing into one, owing to young shoots springing from the bole and instead of forming branches, running up the trunk like buttresses up the side of a church. After a couple of hundred years, the yew-tree grows no higher, but continues to widen its spread and thicken its trunk.

The yew belongs to a genus in which the cone is a fleshy cup called the "aril," in which the single seed is set. The male flower is like a yellow globe growing on a very short scaled stalk. The female flower, which looks like a green bud, develops a fruit like a green egg set in a green cup, which in summer becomes red.

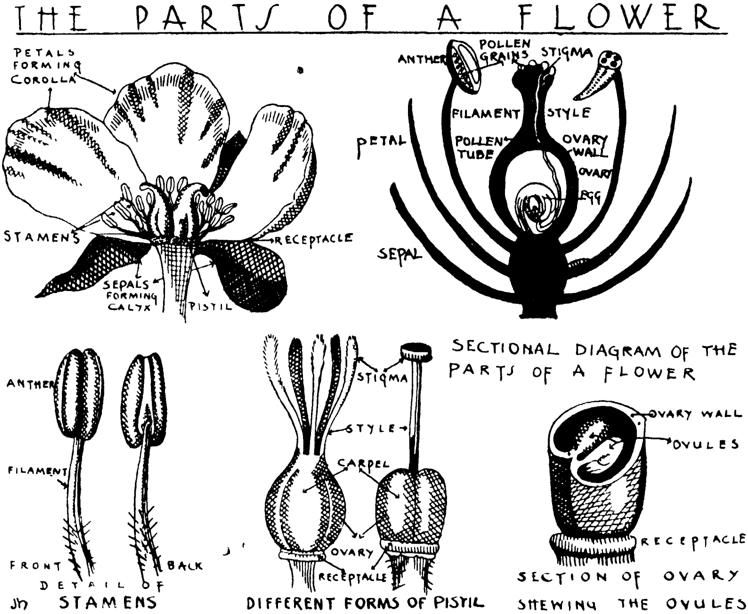
# CHAPTER IV

# ANGIOSPERMS

## (*True seed-bearing plants*)

FLOWERS, like cones, may be of two kinds—pollen-bearing and ova-bearing, though many flowers bear both pollen and ova within them. The pollen grows upon spikes within the ring of petals. The spikes are called *stamens* ; and the top part of the stamens are covered with grains of pollen. This part is called the *anther*. The eggs rest far in the heart of the flower at the bottom of a long cup-like tube called a *pistil*. The top of the pistil, where it receives the pollen is called the *stigma*. The ring of petals surrounding the stamens and the pistil is called the *corolla*. The German poet Goethe believed that the petals are leaves that have become adapted to the special petal-form. This is probably true. Very often the petals have special green leaves outside them to support them and to protect them from damage while they are in bud : these leaves are called *sepals* ; and the whole ring of these green leaves is called the *calyx*. When the flower is only a bud, the sepals enclose it, unfolding and revealing the flower in due season. In some cases the sepals wither and die and fall off when the flower opens fully. The resting place of the eggs, beneath the base of the corolla, is called the *seed case*, and in this seed-case ripens the seed or fruit when the life of the petals, the stamens and the pistils, is over.

But in order that a seed be formed, a grain of pollen from the anther on the stamen must land on the sticky stigma, where it will grow and send a tiny tube down the




pistil on to an egg in the seed case. The nucleus of the pollen grain passes down this and joins with the egg, thus fertilising the egg. In a few flowers the wind shakes the pollen from the spikey stamens on to the stigma of the pistil within the same flower. Such plants are said to be *self-pollinated.*

The vast majority of flowers, however, are *cross-pollinated*: that is, the pollen from one plant is carried to the ova of other plants ; and this is by far the most successful way. When a team of players in a game gets " stale " the remedy is to get in " new blood " in the shape of untried players, strangers who may turn out champions and pull the team together. In much the same way, pollen from another plant of the same species will liven up a flower, will produce more and better seeds ; and so flowers are constantly seeking cross-pollination.

This cross-pollination was at first achieved by means of the wind, the wasteful wind that " bloweth where it listeth " ; and to this day very many plants throughout the

world rely upon the wind to carry their pollen to the ova of other plants. But how much life is lost in this way, because of the millions of pollen grains that get scattered and die !

And then, in the early world appeared a new form of creature, a little creature with wings and a busy tongue, buzzing and settling in the flowers in order to lick up the sugary oil, called *nectar*, which oozed out by accident in the middle of the corolla. This sugary oil was really a *waste product* of the plant ; but in the end it turned out to be one of the most useful of all plant products.

The little creatures with wings and busy tongues were *insects*, and they were attracted to the flowers by their smell. The smell of plants is caused by another oil, called *attar*, which evaporates in such a way as to bring a response in the nerves of certain living beings, including insects and men.

Smell is not like sound or light. It is not a wave-motion of energy. It is caused by the evaporation of certain liquids, which float out as gases and produce the sensation of certain smells. When you smell a rose, real molecules of the vapourised oil called attar float into your nose and touch your *olfactory cells*.

These accidental products of flowers, the smell and taste of the waste oils that oozed out of them, like sweat oozing out of a hard-working man, brought the new flying animals to the flowers to drink ; and so delicious did the insects find these oils to be, that it became their habit to visit flower after flower, filling up their pouches with the sweet oils and taking the oils home to store them for the season when there were no flowers.

Naturally enough, the clumsy, greedy insects, pushing their eager way past stamens and pistils to the cells of sweet oil, got covered with the pollen, and when they visited the next batch of flowers on another plant, some of the pollen grains would nearly always get shaken down the pistils ; and so the insects began to aid cross-pollination, which was the great need of the flowers.

Thus, the strange communion between insects and flowers

began by accident, but after many ages the regular habits of insects had a strange effect upon flowers. In the beginning, the first true flowers had no colour, and had not the deep and clear shapes which to-day we think so beautiful. *Colour only came into the flower world when winged insects began to visit the flowers for nectar.* That is a very wonderful and mysterious fact.

The philosopher Kant says that nature as a whole exhibits to us nothing in the way of purpose ; but he says that nevertheless we can understand an organism only if we regard it as though produced under the guidance of thought for the end.

If we find it hard to believe that brainless plants chose their own colours for their flowers in order to attract insects, and shaped those flowers so as best to attain the end of cross-pollination, there yet seems nothing against the idea, since it is in the nature of all living beings to use natural laws which aid them. We do not know enough about plants to decide what are the extent of their powers ; but at least it seems certain that their vital mechanism did, at the time when flying insects appeared, so adjust the pigment cells of their petals as to reflect such bright colours as would attract the insects to them.

Most flowers are purple, blue, red, yellow or white, as these colours stand out most clearly against the green of the leaves which cover the rest of the plant. Like restaurants hanging out signs in a city street, the flowers assumed their colours by way of advertisement to insects ; and, as in restaurants for men, so in the flower restaurants no diner may leave without paying his check.

All insect-flowers have so adapted their shape to the purpose of pollination that it is almost impossible for the flying customer to leave without getting covered with pollen from the anthers, and enter without shaking some of that pollen on to the stigma of the pistil. Indeed, some flowers resort to drastic measures to secure pollination. There are orchids which throw their insect visitors into a bath of water, so that they have to crawl with wet wings up a

certain petal-path where they touch the pollen masses and the pistil. Some arum lilies have large traps in which they imprison the insects, and let them go only when they are sure to be pollen-dusted.

Many insects visit only certain flowers, and so ensure that the right pollen falls on to the stigmas. It is of no use to anyone if lily pollen falls upon orchid stigmas : on the wrong stigmas, pollen grains have no more effect than grains of sand. It seems to be largely for this reason that species of flowers have different times of opening.

Some wild roses open about 4.0 or 5.0 a.m. Dandelion and nightshade open shop about 6.0. Buttercups and many others throw up their shutters round about 7.0 a.m. Most of these early flowers are shut at noon. Other flowers begin to close about 3.0 or 4.0 in the afternoon.

Although this by no means guarantees that wild rose pollen will not get into nightshade pistil, it does, together with the sameness of colouring of most flowers of one species, help very considerably in getting the insects to visit flowers of one kind at one time. Just as men have favourite restaurants, insects have favourite flowers.

So successful have been these devices in many cases that many insects will not visit any but their favourite flower-restaurants. The regular evening moth-flowers, for example, open about 6.0 p.m. The honeysuckle, the evening campion and the night-scented stock belong to this group. They open at this late hour and remain open until long after sunset, in order to attract the hawk moth, the owlet moth, and other moths which come out at this time, when there are fewer enemies about, and therefore more security. The hawk moths will fly direct to one of these flowers from a distance of a hundred yards or more, and will dart from blossom to blossom with busy precision.

We should be reminded, by the mention of honeysuckle, evening campion and night-scented stock, that smell also is used to attract the insects.

It would seem, for example, that the scent on the pollen brought home to the hive by the worker bees, announces to

the other workers that such-and-such flowers are open in the neighbourhood, and stirs them to seek out these delectable blossoms.

When we come to those flowers which have adapted their shape to the bodies of moths and butterflies, we find that they include some of the most sweetly scented of all flowers—jasmine, hyacinth, tuberose, narcissus, and so on. In these flowers, the scent is devised to attract the insect visitors by imitating the scent of the moths and the butterflies themselves. The scent of these insects plays a part in their courtship, and Mr. Moth, winging his way towards a hyacinth, doubtless imagines he is flying to his lady-love, though probably he is well consoled on his arrival by the nectar which the flower provides.

In the same way as different opening hours assist in cross-pollination, so does the blossoming of different flowers at different seasons ; and possibly this very fact is to some extent the reason why all flowers do not bloom at the same time. The succession of spring flowers, summer flowers, autumn and winter flowers, means that the insects have less chance of making the terrible blunder of dropping daffodil pollen down a dahlia pistil. Doubtless there are other reasons why some flowers like long hot summer days and other flowers like short wet warm spring mornings ; but it is interesting to remember what a short season many flowers have. Few flowers live for more than a month. Most flowers live for less than a week, many for but one day. Some flowers only bloom for a few hours—just long enough for pollination. If they are not cross-pollinated by insects or by the wind, some pollinate themselves. The flower of the wheat plant lives for 15 or 20 minutes and is cross-pollinated by the wind.

When pollination has taken place, the flower's work is finished ; and the period sets in when the seeds grow in the seed-case—that is to say, as we have seen, a tiny imitation of the parent plant grows, and is provided, out of the sun-made starch and sugar, with food for the winter, and a hard case for protection.

Then comes the last problem of the plant—the dispersal of seeds. And here it would seem that the plant has shown most ingenuity of all. For many seeds are too big and heavy to be blown by the wind to suitable fertile soil. This is not the case with many of the smaller seeds, which are often provided with little wings or sails, with kite tails and parachute tops, or covered with light masses of hair-like threads, so that they will float for a long distance in the wind ; and then some are rounded and so formed as to bounce and roll along the ground. Some seeds are given prickly coats like the burrs that so annoyingly stick on one during country walks : the pricks are devised for the purpose of sticking to you, so that you shall distribute the seeds as far as possible from the parent plant. Many fruits and seeds have strong barbs and claws on their outside for the same purpose.

A great number of plants shoot out their seeds like bullets. The seed-cases of these plants are so constructed as to get extremely tight when the seed swells and ripens. When at length the seed is fully ripe it bursts the seed-case and shoots out most alarmingly. There are many variations of this, some of the seed-cases acting like catapults or spring guns.

Perhaps the strangest and most beautiful device of all for the dispersal of seeds is the method provided by fruit. Fruit is a soft, fleshy coat grown around the seed, and it seems that that soft fleshiness was in most cases provided as food for birds and beasts, because birds and beasts contracted the alarming habit of eating seeds, and had to be lured to distribute them instead. Birds and beasts are the biggest visitors of the plants, but plants are adapted to them in their fruits quite as certainly and perfectly as they are adapted to insects in their flowers.

The purpose of all fruit is to provide food for such birds and beasts as will eat the soft fleshy part and throw away the seeds. That's the point : *throw away the seeds*. That's what the plant wants. Perhaps the simplest example is the orange, which is a very cleverly contrived fruit. You will have noticed that an orange has a bitter burning taste in the

skin. That is in order to keep off insects who might otherwise gnaw through to the sweet pulp within. Only a few strong birds and beasts can tear the fruit to pieces and scatter the seeds—such strong creatures as will fling the fruit about and send the seeds a good way off. And then, the seeds of the orange are themselves extremely slippery, and are beautifully adapted to be spat out or flipped away to a distance.

These, then, are the characteristics of the angiosperms, the true flower-bearing group of plants. Complicated, delicate, beautifully adjusted to their environment, they have made their position upon the " dry land " so secure that all animal life depends upon them.

Botanists group the angiosperms into two large classes, which we can easily understand if we remember what a seed is. We likened a seed to a millionaire's son who is given a home and enough to live on until he " takes root " in the outer world. We saw that within each seed is a tiny plant, a miniature imitation of the parent plant. We saw that this plant had at least one minute leaf, and this leaf inside the seed was to supply the baby plant with food until the seed was sown in the earth and sent forth roots of its own. The seeds of conifers may have many of these " seed-leaves," but in certain families of plants each miniature plant in the seed-pot has but one seed-leaf. That seed-leaf is called by the Greek name *cotyledon*. The flowering plants with one seed-leaf form a large and distinct class, and botanists call them *Monocotyledons* (" Single seed-leaf ").

The rest of the flowering plants, having two (sometimes three or more) tiny leaves attached to the baby plant in the seed-pot, are called by botanists *Dicotyledons* (" Two seed-leaves ").

With this simple division of the flowering plants in mind, let us now go forth to look at a realm which is by far the most beautiful and mysterious of all those living realms with which our lives are interwoven, the realm of the true flowers.

## MONOCOTYLEDONS

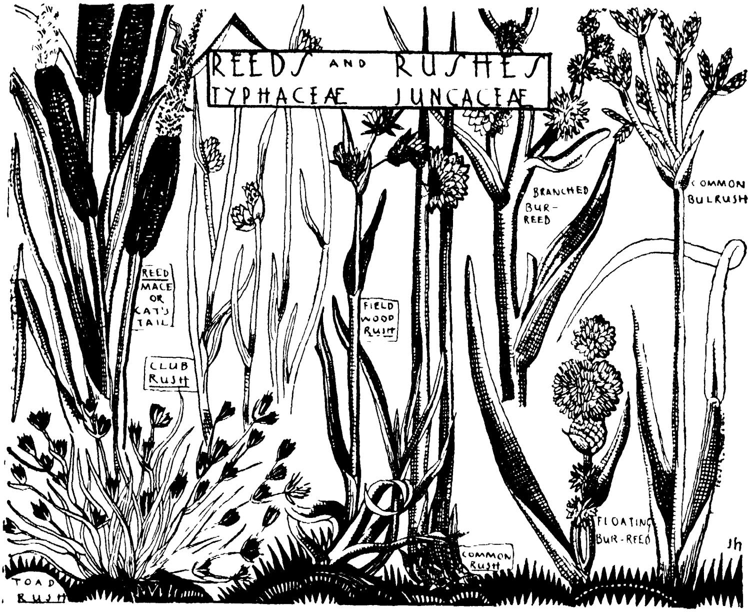
*(Plants which have one seed-leaf)*

The fact of having but one leaf in the seed is linked up with certain characteristics in the grown plant, by which one-seed-leaf plants may be distinguished from two-seed-leaf plants. For instance, when a plant which had one seed-leaf grows up and puts forth its own leaves, those leaves will usually have their veins running " parallel " to one another, from the axil of the leaf to the tip. Take half the world as an illustration.

A map of half the world is a flat sphere, or *circle*. The lines of longitude all start from a point we call the South Pole, and, running " parallel " to one another, all meet again at the North Pole. In the same way in monocotyledon leaves, all the veins start from the axil, which is the base of the leaf, where it springs from the stem, and meet again at the tip of the leaf.

The veins of leaves are of course both the skeleton and vascular system of the leaf, holding it together like bones, and at the same time acting as a water-supply, a tube-system through which the mineral-filled water reaches the chloroplasts, and by which the food-water returns to nourish the plant.

There are many other characteristics of monocotyledon plants. Their vascular system throughout the plant is differently arranged from that in dicotyledons and they tend to be herbaceous—that is, they die down every year, though not all *herbs* are annuals, because the roots of many kinds of herbs live on under the soil and produce new plants in the following spring. Their flower-parts—petals, sepals, stamens, etc.—tend to grow in sets of 3 or the multiples of 3. But we must begin to visit a few of the 45 monocotyledon families in order to see more clearly their special characteristics.




## REED MACE FAMILY or CAT TAIL FAMILY

(*Typhaceae*)

Everyone knows the tall dark armies of the bulrushes beside the lakes and rivers and the rustle of their long, sharp-edged leaves, when the wind and waters wave their close-clustered stems. The Latin name of the plant which to-day is popularly called bulrush in Britain is *Typha latifolia.* Another English name for it is the reed mace. It has a long, creeping underground stem, narrow, nearly flat leaves, 3 to 6 feet long, arranged on the stem in two rows opposite to each other, the leaves springing from the stem on one side and the other alternately. The stem ends in a thick round spike which may be 6 inches to a foot in length. This spike is a dark brown colour and is soft and velvety to the touch. It is the spike which is called the cat's tail, from which the family gets its

popular name. Actually the spike is a mass of tiny flowers pressed together. These flowers are of two kinds, male with stamens on top, and female, each with a pistil beneath ; and every flower is on a little hair-like stalk. The flowers come out in August, and those beneath turn into fruit in September. Each tiny fruit bears one seed within it. The fruits are covered with long downy hairs which aid them to be carried far by the wind when ripe.

There are many varieties of cat tails ; and the plant which used to be called bulrush, the original bulrush, belongs to another family, called *Cyperaceae*. Moses' bulrush is the Nile species, called *Papyrus antiquorum*.

There are several other families of rushes and rush-like plants, and some close relatives of theirs dwell almost completely under the water.[1]

Another family of water-plants closely related is the very common duckweed family, the smallest of all flowering plants, consisting mainly of chains of little leaves, floating on the surface of stagnant water, bearing tiny flowers and fruit, and sending down frail roots to the bed of the pond. The duckweeds are found in all parts of the world.

The most lordly relative of all these lowly water-plants is the

## PALM FAMILY

(*Palmae*)

This, being an exclusively tropical and sub-tropical family, is outside the scope of this book ; but with the world of nature in mind, we can hardly pass by a group of beautiful tree-like plants which supply great masses of mankind with their chief article of food.

We see a few species set out as ornaments in our southern watering-places and botanical gardens.

And so we come to the most common, the most widely spread, the most valuable of all the families of plants, the

[1] A popular name for many forms of rush-like plants is *sedge*.

## GRASS FAMILY

(*Gramineae*)

To talk about the " grass family " is almost like talking about the " animal family," so many and so varied are these infinitely valuable plants. We certainly must give a whole chapter to the grasses.

# CHAPTER V

# THE GRASS FAMILY

IT WAS ONLY when men conquered and controlled grass that civilisation began ; for, only then could men settle, only then could they cease the search for food, and be assured of a regular supply in one place.

*Pasture* is grassland brought under control. We depend upon pasture for all our milk and meat, for all our leather and wool, since it is upon pasture that cattle and sheep depend.

We depend upon grass, also, for all our bread. During untold ages in prehistoric times certain wild grasses were tended by men, and through this cultivation they came to change their nature, to become finer in quality, so as to contain the rich nutritious meal that we call flour. No wild grass in the world could produce such flour : it is the result of the cultivation carried on by men, which has produced from certain wild grasses the *cereals*, such as wheat, barley, oats, rye, millet, rice, maize. We apply the name " cereal " to any sort of cultivated grass which produces flour.

The seeds of cultivated grasses (cereals) are called *grain* ; and for so long have cereals been cultivated that in many cases the wild grasses have become extinct. The wild forms of barley are found on every roadside, and cultivated barley must in the beginning have arisen from one of these forms ; but none of the cultivated kinds of wheat are known in the wild state, though some of them are believed to be descended from the grass called wild emmer, which is found in Palestine and Persia.

So far away and so long ago are the beginnings of the cultivation of cereals that it is only in more or less recent times that men have realised the truth about grass. For long ages men forgot that cereals had been slowly and painstakingly cultivated from wild grasses. They put the creation of cereals down to their gods.

The Greeks believed their cereals were created for them by the goddess Ceres ; and it is from the name of the goddess Ceres that our word cereal is derived.

We now know that men, by assisting nature, produced the cereals from the wild grasses. By ploughing the earth, by weeding, by sowing, by manuring, by irrigating, by all the art and craft of the farmer, men enriched the earth and themselves by cultivating the right kinds of grasses.

Ploughing the earth gave more air-space to assist the roots to grow ; weeding relieved the seeds from the terrific struggle against other kinds of plants ; men learned to sow in the ploughed and weeded soil the strongest, healthiest seeds, so that the soil was not cluttered up with weakly plants : men learned to aid the work of nature by adding rich stores of minerals and decaying plant-food and animal-food to the soil in the form of *manures* ; and they learned how to protect the plants from drought by making systems of water channels and canals—what we call *irrigation* systems—and from flood by making drainage systems ; by all these, and other means as well, men *conquered the grass.*

They had by them waving fields of golden grain for their bread ; and so men could build cities.

All the cereals to which man owes his civilisation are annual grasses, bearing one crop and then dying, though *rye* sometimes appears to be perennial. An *annual* among plants is one that lives for but a year, or for a single season : in the case of annuals, the continuance of the kind is due solely to the seeds bringing forth a new generation next year or next season. A *perennial* is one that lives over from year to year.

The most important cereals are wheat and rice—wheat being the basis of the civilisation of the west, rice being the

basis of the civilisation of the east. The other cereal grasses contribute their quotas of special mealy stuffs for the welfare of man and beast throughout the world.

It is not a matter of mere interest, therefore, but is of no little importance, to be able to tell the different cereals that wave in the fields about you, and to know the different kinds of pasture grasses that clothe the green meadows. For these plants are the gold and green background of our great cities. It has been estimated, for example, that the average day's labour of one man on a wheat farm produces enough food to feed that man for a year. On this basis, a man who works 300 days in the year on such a farm produces enough food to feed 300 men for a year ! Which reminds us of what farms are for. . . .

Let us, therefore, look at grasses. . . .

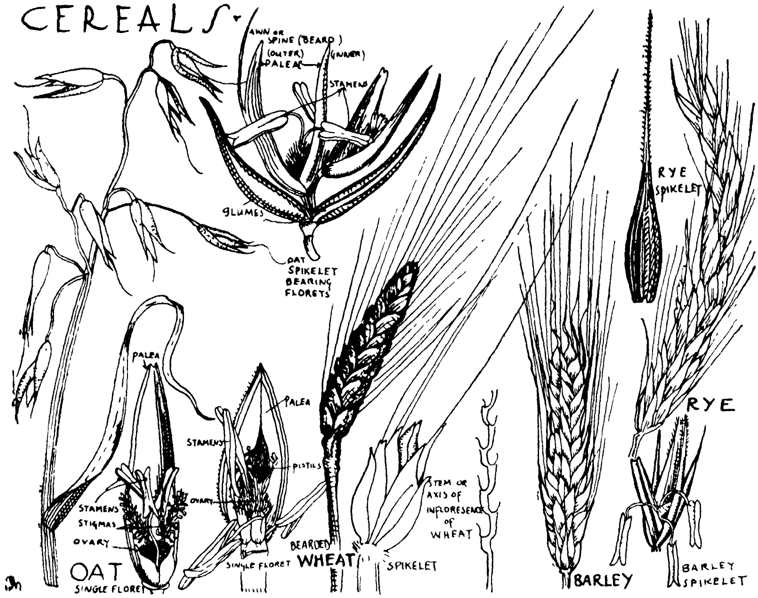
The stems of all grasses grow up in sections jointed together, the joints being called *nodes*. Between the nodes the stems are usually hollow. The branches on grass plants always spring out from the nodes ; which is not to say that every node has a branch, or branches, but only that branches never spring out from the stems between the nodes. The leaves of grasses are always surrounded on their lower portions by a sheath fixed to the node. This long sheath is split and out through the split appears the long, narrow, ribbon-shaped leaf, which is the characteristic we chiefly remember about grass. When we speak of " green grass " we speak of the long upstanding green leaves of grass.

The flowers of grasses grow in *inflorescences*, which is a general name for the way in which the flowers of many plants group themselves upon a single stem. The catkin (see Chapter VII) is an inflorescence ; and so is the female cone of conifers (Chapter III). The inflorescences—the flower-groups—of grasses are formed of several *spikelets*, these being bunches of little flowers. In different sorts of grasses the flower-bunches are arranged differently. In nearly all grasses the flowers are of the very simplest sorts, bare stamens and pistils, protected by bracts. The anthers

of the stamens usually dangle on slender threads below the stigmas of the pistils, so that the pollen is blown away to another flower. Grasses are nearly all wind-pollinated, so that the flowers have no need of bright petals to attract insects. Some of the cereals are self-pollinated, however.

**Wheat** (*Triticum sativum*). Chief of all cereals, and most valuable plant in the world, is wheat. The inflorescence of wheat is called the " ear." This ear is a stemful of spikelets arranged in a regular and orderly manner. The round stem of the plant goes flat when it reaches the ear and bears notches on each side alternately—the notches are on opposite sides of the stem, but not opposite to each other : there is now one on this side, now one on that. On each of these notches (which are like tiny platforms one above another), a single wheat-flower grows or perhaps two or three little flowers forming a spikelet. At the base of each flower, enclosing it until the flowers unfold, are two boat-shaped sheaths, called *glumes*. Inside the flowers themselves, protecting the stamens and pistils, are two further sheaths shaped like the glumes : these are called *paleae*. When these tiny flowers have been pollinated, and so fertilised, and develop into the fruit, the whole inflorescence becomes the familiar ear bearing the grain in what looks like a rich plaited plume. The sheaths of the flowers are become the husks protecting the grain—those husks which are spoken of as chaff ; and are separated from the grain at the winnowing. There are a great number of varieties of wheat.

**Barley** (*Hordeum sativum*). Each notch on the ear-stem bears usually three flowers. The glumes of barley are longer, more slender and pointed than those of wheat ; otherwise the plant in general appears very similar. Of the many species of barley cultivated in this country, six-rowed, four-rowed and two-rowed barley are those most frequently met with. The six-rowed barley and the four-rowed barley




have three flowers in each spikelet and each flower produces one grain ; and in the six-rowed variety these sets of three grains on each side of the ear give six rows of grains one above the other : in the four-rowed variety, the spikelets and the grains which develop in due season are arranged upon a slightly different pattern, giving the effect of only four grains in a row, though actually the ear is as rich in grain as is six-rowed barley. Two-rowed barley is definitely of a poorer quality than the other two varieties, only the middle flower of each spikelet being female and producing grain.

Oats (*Avena sativum*). Instead of having one notched stem, the inflorescence of the oat breaks into several branches, and these often break into more branches, giving the oat a widespread, dotted-about appearance, very unlike the compact ears of wheat and barley. Upon the end of each free-swinging branch grows a spikelet. Inside the glumes of

each spikelet a slender stem bears from two to five little flowers, usually three flowers. One of the inner sheaths (paleae) that protect stamens and pistils bears a thread-like spine. Cereals bearing these spines are called " bearded " : there are varieties of " bearded " wheat, and other cereals also have " bearded " varieties. There are many varieties of oats.

**Rye** (*Secale cereale*). Only one species, common rye, is cultivated. The ears of rye are upon a single stem, like wheat and barley. Spikelets are three-flowered, the whole plant richly " bearded," long thin spikes coming from the inner sheaths of the flowers. In a field, the rye plant appears to have a tinge of blue. The grain is darker in colour and more slender than that of wheat.

The above four cereals are the chief crops in Britain and throughout the temperate zones ; and with the addition of not much more than a dozen other crops such as millet, rice and maize, they make up the sum total of cultivated grasses. There are certainly less than twenty cultivated grasses ; although the *varieties* of the cultivated species run into some hundreds. It is queer that so few cereals should suffice for man's agriculture, when in the grass family there are at least 500 genera and certainly over 4,500 species ! With a brief description of the more common of the pasture and wild grasses in Britain we must, however, conclude our survey of the *Gramineae*.

**Creeping Bent-Grass** (*Agrostis alba*). A perennial grass with ground-creeping stems, which send forth roots from the nodes. This grass often grows in dense tufts, not above two or three inches high ; but the flowering stems may spring up to one or two feet, and bear a delicate spread-out inflorescence at the top. Found so often growing in neglected corners of meadows, in the " rough " of golf-courses, on the uncared-for edges of copses, the inflorescence makes the creeping bent-grass noticeable. On the much-branched

inflorescence, one flower is borne on the end of each branch, a minute flower, with glumes (outer sheaths) twice as long as paleae (inner flower-sheaths). It flowers the whole summer, the flowers having a light green or purplish tinge. This grass is often considered a weed, since it is not a rich pasture grass, but it is planted as a fodder grass in some places because it cannot be injured by cold, and can be used for grazing even in December. Several varieties.

**Foxtail Grass** (*Alopecurus pratensis*). One of the earliest fodder grasses of spring, flowering from April onwards, the foxtail grass has a far closer and thicker inflorescence than creeping bent grass, the spikelets being born on very short branches springing off the main stem close together, so forming a " poker " of florets on top of the stem. This grass also withstands extreme cold, and grows well under trees. It is a pasture plant, and forms loose tufts of quite broad, blade-like leaves. Several varieties.

**Vernal Grass** (*Anthoxanthum odoratum*). " Comparatively poor in nutritive value and bulk of produce, this is the earliest of fodder grasses in spring ; is almost unaffected by drought, cold or excessive wet." The spikelets are one-flowered, narrow and crowded into a spike-like inflorescence. The flowers have six glumes, several with hairy spines, giving the flower-group a feathery appearance. The flowers are tinged with yellow and the whole plant has a pleasant smell : it is sometimes called Sweet-scented Vernal-grass. Perennial. Only one species in Britain.

**Oat Grass** (*Arrhenatherum avenaceum*). A tall perennial, with loose, erect tufts of blade-like leaves. It has roots of a chrome-yellow colour and the bottom nodes of the flowering-stems are often thickened, or bulbous, and are sometimes coloured like the roots. It flowers as a rule in June, the flowering-stems being 2 to 4 feet high. The inflorescence is large—6 to 10 inches long—and droops over on one side.

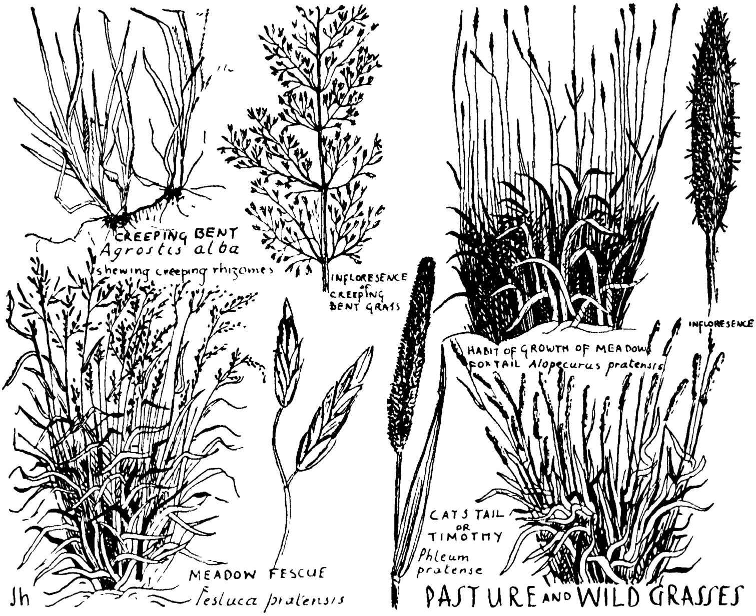
The spikelets contain two flowers, the upper one " perfect," the lower one male (with stamens only). The glumes are unequal in length and sometimes of a purple colour. There are many common varieties of oat grass.

**Wild Oats** (*Avena fatua*). A tall annual, growing much among cereal crops, forming close tufts. Like its cultivated brother, the wild oat's inflorescence is an untidy-looking affair, not gathered into a neat spike, but dangling on widespread branches, which, however, spring off the main stem equally from all sides. The spikelets hang down from the ends of the branchlets, and each contains two or three flowers. The glumes are smooth, papery and pointed. This plant is by no means a pasture grass, but a common weed.

**Dogstail** (*Cynosurus cristatus*). In rather dry, hilly pastures and downs one can find plenty of the small close tufts of the perennial known as crested dogstail. Flowering at the end of June, the inflorescence forms a small thick spike, 1 to 2 inches long. The flowering stem is thin, smooth and wiry, from 9 to 15 inches high.

**Cocksfoot** (*Dactylis glomerata*). One of the commonest of all grasses, this perennial flowers from May to August and may easily be known by the tiny tufts of spikelets that grow on little branches at the end of the flowering stem. Often there are three or four of these fragile feathery spikelets each on a very short branch springing from the tip of the stem ; and this spread-out inflorescence is said to resemble the footprint of a cock. The spikelets have three to five flowers each. The leaves of this grass, which grow thickly and tend to form cushion-like tufts vary greatly in colour and may be light green or deep blue-green.

**Fescue Grasses.** There are several species of fescue of which Tall Fescue (*Festuca elatior*) and Sheep's Fescue




(*Festuca ovina*) are the most common : there are several varieties of both these species : Meadow Fescue, for instance is a common variety of Tall Fescue. The fescues are known by the wide-spreading inflorescences. As in cocksfoot, the spikelets are borne in little tufts at the ends of branchlets on the tip of the stems ; but instead of only three or four of these branchlets, the fescues form loose, drooping, graceful plumes of twenty or more. They are all perennial.

Rye Grass (*Lolium perenne*). The inflorescences of this perennial grass are not unlike the " ears " of wheat and barley in general appearance, though of course, far smaller and more fragile ; but the spikelets are borne alternately upon little notches in the stem. Each spikelet contains from six to ten flowers. This grass is usually of a dark green colour, the blades smooth and glossy on their under-sides, dull above. Two or three varieties.

**Cat's Tail** (*Phleum pratense*). Sometimes called Timothy. The inflorescence of this grass is a dense spike of little flowers, from one to four inches in length, borne upon a stem one to three feet high. Perennial. Flowers July. Colour of leaves, etc., light green.

**Meadow Grass** (*Poa pratensis*). A common species throughout the British Isles in pastures, meadows, and on road-sides. It is a perennial and puts forth underground stems that shoot up in further plants (underground stems of this kind are called *stolons*) so that many plants may be joined underground, having one root. This is not uncommon in the grass family, and many grasses can form thick matted turfs by such means. Inflorescence of *Poa pratensis* two to three inches long, with slender, spreading branches. There are many varieties of meadow grass.

**Couch Grass** (*Agropyrum repens*). The inflorescence of this beautiful grass is arranged as in the " ears " of wheat, barley, etc., but far more widely spread, giving a comb or feather-like appearance. The spikelets spring from notches on the central stem and aspire upwards in regular succession on either side. . . . The spikelets contain four or five flowers each. The flowering-stem may rise to three feet in height.

**Tufted Hair Grass** (*Deschampsia caespitosa*). A very common perennial growing in large dense tufts in moist and shady places. The leaf-blades of this grass are sharply pointed, a fact which must have brought it to the attention of many of us before we knew its name. It is sometimes called " tussock " grass and " hassock " grass. The inflorescence is spreading and oat-like. The spikelets contain two or three flowers.

**Brome.** The bromes are a numerous genus of coarse, hairy-leaved grasses, the species of which are mostly useless for

pasture. The more common species are : Field Brome Grass (*Bromus arvensis*) and Soft Brome Grass (*Bromus mollis*). The grass called False Brome Grass (*Brachypodium sylvaticum*) is of another genus. It is generally called a woodland grass.

Of the almost innumerable species of *Gramineae*, the species described above are enough to get acquainted with. There are other grasses common to special places, such as the marram grass that binds the shifting sands beside the sea ; but we must journey onward in our ascent from the single-celled diatoms and early lichens up to the royal family of the plant world.

# CHAPTER VI

# THE FLOWERS

## (*Monocotyledons*)

## LILY FAMILY

### (*Liliaceae*)

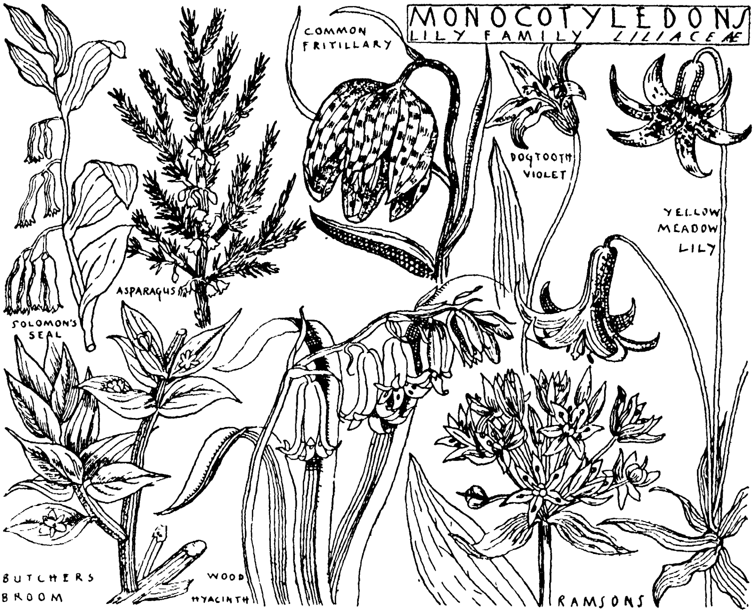
THIS GREAT FAMILY of 250 genera and about 2,700 species contains many of the most gorgeous ornaments of our flower gardens. Anyone who has gazed over the tulip farms of Holland in the flower season will have marvelled at the glorious colouring given to the world by the *Liliaceae*. Most of the members of this family are perennial herbs ; but a few, like the *butcher's broom*, are shrubs, and there are some strange, beautiful tree-like forms, such as *Dracaena*, *Yucca*[1] and *Aloe*.

It is usually fairly easy to tell what family a flower belongs to, if you know a few of the special characteristics[1] of the families. You can generally tell a member of the lily family, for instance, by the fact that each flower has six stamens and an *ovary*[2] in the centre, and all the leaves are long and have veins that run in the same direction : that is, the veins are parallel, which shows they are monocotyledons.

Thus, the bluebell has six petals, six stamens, and one ovary in the centre. The leaves of the bluebell are not so broad as lily leaves, but they are long and the veins are parallel. Therefore the bluebell belongs to the family

[1] For an account of the Yucca and Yucca-Moths, see Chapter I, Book Three.

[2] Ovary is the name for the resting-place of the ova of flowers.




*Liliaceae*. So, for the same reason, do the tulip, the hyacinth and the Solomon's seal. The tulip blossom faces upward to the sun, the bluebell hangs her blossoms downwards towards the earth, but they are close relatives because they have this close resemblance in structure. It is for some such resemblances that all the flowers of garden and open country are grouped into families. They are seen to be related to one another, as cats and tigers are related to one another, and dogs and wolves.

There are at least sixty species of lily growing in all parts of the world. These range in size from the giant lily of the Himalaya Mountains, which rises ten feet from the soil and covers many valleys in that wild " roof of the world " with a dancing splendour of colour every hot season, to the wild meadow lilies and wood lilies of Europe and America. The six petals of the *meadow lily* are pointed and curl backwards. They are pale orange in colour, darker inside than out, and spotted with brown. The six long green stamens in the

centre have big brown caps of pollen on top (the *anthers*). The pistil also has a brown tip (the *stigma*).

This glorious little meadow flower has a cousin, the *wood lily*, whose six petals are bright sunset-red, with yellow or brown spots, and these petals narrow down at the base, so that each appears to grow upon a red stem of its own, branching out above the seed-case. The six stamens are of a delicate pink colour with a brown packet of pollen on top ; and once again the pistil has a brown top (stigma) where it receives the pollen.

Perhaps the loveliest of all lilies is the Madonna lily. Ben Jonson called it " the plant and flower of light." In the Middle Ages our ancestors placed the Madonna lily as a symbol of their lives in the hands of the images of saints. The Madonna lily is a native of southern Europe, of Palestine, and Asia Minor, and was probably that lily of the field referred to in the New Testament.[1]

One of the most beautiful, and therefore one of the truest, descriptions of this lily was written by a thirteenth-century scholar, Bartholomaeus Anglicus, in his book *De Proprietatibus Rerum* (" On the Nature of Things "). " The lily is an herbe with a white flower ; and though the leaves of the flower be white yet within shineth the likeness of gold. The lily is next to the rose in worthiness and nobleness. Nothing is more gracious than the lily in fairness of colour, in sweetness of smell, and in effect of working and vertue."[2]

The " likeness of gold " within the pure white petals, is the golden anthers of the stamens. The petals of the lily enfold this gold pollen as if in a cup.

Of the great variety of other lilies we can but name a few

[1] " Consider the lilies of the field, how they grow ; they toil not, neither do they spin, yet I say unto you, that even Solomon in all his glory was not arrayed like one of these." (Matthew vi. 28, 29.)

[2] Bartholomaeus Anglicus (" Bartholomew the Englishman ") was a Franciscan, and was one of the greatest theologians and naturalists of the thirteenth century. His book was the source of common information on Natural History during the Middle Ages. Scholars rank Bartholomaeus next to St. Thomas Aquinas as a theologian, and they put him beside Roger Bacon as a natural scientist.

of the better known ones, such as *lily-of-the-valley*, the lovely little wildflower with a series of white bell-shaped blooms, swinging upon an overhanging branching stem and which have such an enchanting smell, the *tiger lily* from China, with its deep orange colour and bold black spots, and upward or sideways-pointing flowers much resembling the meadow lily. The water lily belongs to another family, called *Nymphaeaceae*. Other members of the lily family include the tulip.

**Tulip** (*Tulipa gesneriana*). I have always been just too early or just too late to see the full beauty of the tulip in the fields of Holland, but I have seen a few fields stretching away as if to the end of the world. The tulip is not by any means the only flower cultivated on the Dutch bulb farms : I have seen hundreds of acres near Haarlem ablaze with blooming hyacinths.

The tulip is one of the favourite garden flowers all over the world. The lines of its cup-like petals are pure and severe, like a Grecian urn, its colours, too, are sure and deep ; and gardeners are always trying to breed fresh " varieties " for colour, though the famous " Black Tulip " that Alexandre Dumas introduced into one of his adventure tales, has never yet been produced.

The tulip of our gardens is a native of Asia Minor and Greece, and is not found wild in our lands ; but the lily family has provided us with several of our finest wildflowers.

**Bluebell** (*Scilla nonscripta*). Every year great numbers of people march through the " bluebell wood " in Kew Gardens during the spring. No one who has seen that wood with its carpet of blue can ever forget the colour. It is as if the blue which lurks in mountain mist has been caught and imprisoned within those hundreds of thousands of bobbing flower heads that stretch away down the glades. In the centre of this wood in Kew Gardens is preserved the old thatched cottage of Queen Victoria. The Queen left instructions that the bluebell wood remain untouched, for

the enjoyment of the people when bluebell time comes round.

Yet if you will march but a few miles away from any city in Britain in bluebell time, you will come upon deep mysterious woodland glades that shine with the strange glorious light of the bluebells ; and not only do they lurk in woods. I have sat on the open downs of Sussex, the "whaleback downs," as Rudyard Kipling calls them, and before me in the distance the pale sea has glinted in the golden sunshine, and between where I sat and where the sea sparkled, there ran a belt of bluebells a mile long, fifty or sixty yards across, a belt of blue not quite like the blue of any sea, not quite like any blue of sky—a blue with just that quality of mist-made-clear which is bluebell blue.

It is easy to appreciate the beauty of bluebells, with their faint sweet smell ; it is less easy to enjoy the splendour of the bluebell's cousin, the wild garlic.

Garlic (*Allium*). Though garlic has a strong distasteful smell like onions, it is actually a beautiful white flower, clothing many a woodland and meadow with a pearly blossom in the early part of the year. The flowers of the garlic grow in stalked clusters at the tops of long stems, and they are like beautiful six-pointed stars of pure white. In the centre of each flower lie three green balls joined together, with the seeds of future plants inside them, and a slender white column, the pistil, standing in the midst of them. Six white threads, with cream-coloured or pale yellow tops, the stamens with anthers, form a ring about the balls.

This plant is sometimes called ramsons ; and is a close relative of the *onion* and the *leek*, both of which useful vegetables belong to the lily family. Another useful and delicious vegetable in the lily family is the *asparagus*. If it seems strange that onions and tulips, garlic and Madonna lilies are all so closely related, we must remember how men have aided many plants to develop along different

lines. The onions of our kitchen gardens are no less cultivated than the tulips in our flower beds ; and in general, wildflowers are smaller and are often less unlike one another than are cultivated varieties. The lily seems to be rather an exception, since all the efforts of the gardeners have had small effect upon this plant.

But we must hurry on to the multitude of flower families awaiting our attention. We must bid good-bye to the lilies by setting down a brief list of a few of the better known genera in the family. Remember there are 250 genera containing 2,700 species, so naturally we are unable to give more than a few.

**Solomon's Seal** (*Polygonatum*). A small genus which used to be found in Britain but is now very rare. It is found in Europe and America, has oval leaves smooth above, covered with fine hairs below, and tiny bell-shaped flowers of yellow (sometimes green) swinging in pairs on stalks below the leaves.

**May-Lily** (*Maianthemum*). A small species. Europe, Asia, North America.

**Dog-Tooth Violet** (*Erythronium*). A common wildflower of Britain and America.

**Fritillary** (*Fritillaria*). A beautiful genus with two or three species. Rather like a tulip, with chequered petals.

**Star of Bethlehem** (*Ornithogalum*). A small white blossom often seen in the hedgerows.

**Grape Hyacinth** (*Muscari*). A small genus, with tiny purple blossoms that look more like a cluster of berries than flowers.

**Allium.** This genus includes the important species of *leek* and *garlic.*

**Bog Asphodel** (*Narthecium*). A single species with bright yellow flowers abundant over North America, Europe and Britain, where it grows in bogs and wet places.

**Hyacinth** (*Hyacinthus orientalis*). The lovely cultivated garden flower.

## ARUM FAMILY

(*Araceae or Aroideae*)

This is a smaller family than that of the lilies, but it is accounted one of the larger flower families, having more than 100 genera and over 1,000 species. The largest members are found in swamps and rain forests in the tropics ; but several species grow wild in our own land.

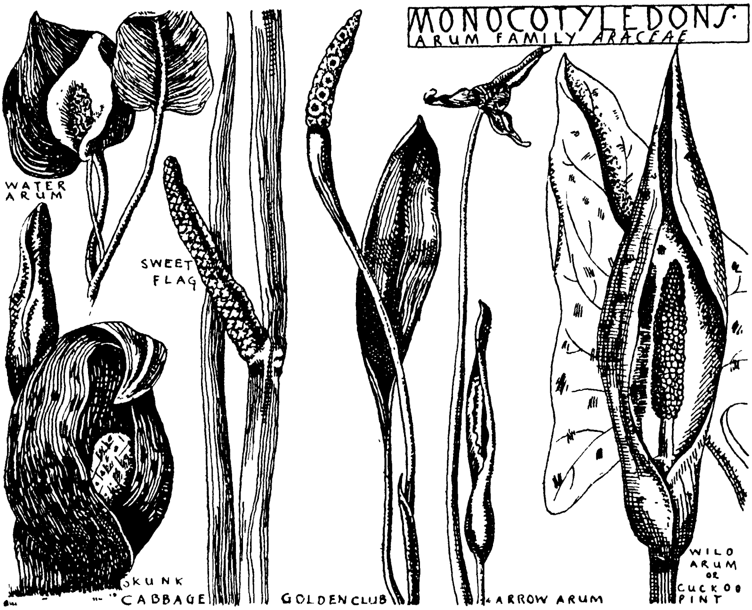
The flowers of this family are small and are crowded on a thick spike, called a *spadix*, which is, in most species, protected by a large leaf called the *spathe*. This leaf rises up and overtops the spike of flowers like a huge monk's cowl.

**Cuckoo-Pint:** sometimes called **Lords-and-Ladies, Wake Robin, Wild Arum, Jack-in-the-Pulpit** and a score of other names. This wild flower is found in the early spring in many woodlands, meadows and waysides, and it shows very plainly the characteristics of the Arum family.

It is one of the earliest spring plants. The leaves are large and glossy and are shaped roughly in the likeness of barbed arrow-heads. They are sometimes blotched with spots, which may be dark purple or yellow, but sometime disappear.

The flower has no calyx (ring of protecting leaves). It has only the one large leaf which at first completely hides it. This leaf curls right round the young flower, and reaches up to a point over the top.

In April, or even during a fine March, this leaf unfolds at one side, revealing the flower. The leaf remains covering




the flower over the top, and we have to peer in the opening of the half-curled leaf to find the flower. Then we find, not one flower, but a cluster of small flowers growing on the stiff little spike (*spadix*). The flowers do not grow on top of the spike, which may be pink or purple or crimson; they are set further down, and are very extraordinary flowers indeed, since they have no petals, being just bare stamens and pistils. Even the stamens and pistils of these flowers are very odd.

First, a number of half-grown stamens spring out of the spadix. These stamens are like thin hairs, and they never grow up to bear pollen: they are used for quite another purpose, as we shall see in a minute. Below these, comes a bunch of real pollen-bearing stamens. Below these again are some more fine hairs, which are pistils that never grow up, and below these once more are true pistils with ovaries awaiting fertilisation by pollen.

It would seem an easy matter for the cuckoo-pint to

achieve self-pollination by letting the pollen grains from the real stamens fall upon the true pistils below ; but this wary plant does not want to do that. It knows that self-pollination weakens a plant ; and those weak hair-like half-grown stamens and pistils are designed by the urge within the plant, to achieve cross pollination by insects.

In some cuckoo-pints you may find a thousand and more small insects, such as midges, held prisoner until such time as the plant wishes to release them. These insects climb down the spadix to reach the sweet oils at the bottom. When they have drunk some oil they try to climb up again ; but those thin hairs of the ungrown pistils and stamens droop across the way up, like iron bars ; and the insects have to remain crowded at the base of the spadix.

By and by the pollen from the true anthers ripens and then the lower ring of hairs withers, allowing the insects to come up and get covered with pollen. The top ring of hairs then withers and dries up, and the insects can escape. The obliging insects then fly away to a neighbouring cuckoo-pint to replenish their supply of sweet oil. They crawl down the spadix to the base, laden with the pollen from the plant they have just left, their burdens fall from their little bodies on to the stigmas of the pistils, and in this way cross-pollination is achieved.

The fertilised ova then begin to swell into bright scarlet berries. The spathe (the great hood-leaf) the spadix and the flowers wither and fall off, and the bunches of brilliant red berries are to be seen in the summertime in many a wood and hedgerow. But beware the red berries of the wild Arum, for they are poison ! In fact, in spite of the interest of this plant, it is very much neglected, for not only are the berries poisonous, but the flower itself has a bad smell, like dead meat : it is this smell which attracts the insects and enables the plant to dispense with petals. The coloured spadix of the flower, however, helps to bring the plant to the notice of insects, and so probably do the blotches on the leaves.

Many of the flowers in the Arum family arrange traps

for insects in this manner, but we must pass on to the next flower family, giving here only a brief list of a few chief members of the *Araceae* or *Aroideae*.

**Arum Lily** or **Calla Lilly** (*Zantedeschia* or *Richardia*). A cultivated plant of the gardens, a native of Africa.

**Wild Calla.** Found in bogs in cool north temperate and subarctic regions. A handsome plant with heartshaped leaves, showy white flowers, and brilliant red berries.

**Sweet Flag** (*Acorus*). A single species distinguished as a genus by the leaf-like spathe not completely covering the spadix. The flowers grow over every part of the spadix which is 2 or 3 inches long. Sweet, scented. Sometimes called sweet sedge.

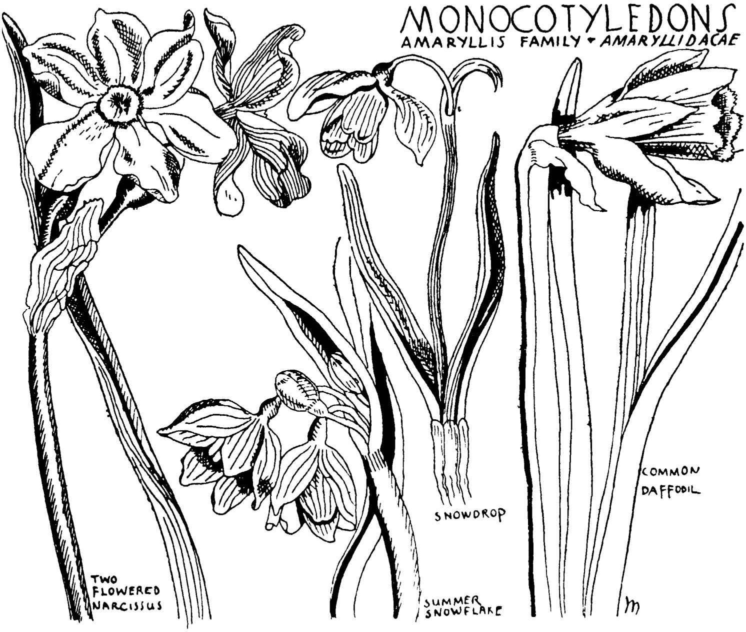
## AMARYLLIS FAMILY

(*Amaryllidaceae*)

The daffodil really belongs to the genus *Narcissus* within the family Amaryllidaceae. The sweet wild daffodil stores up its food in a little bulb, from which it sends out tiny roots to hold it to the ground and to draw up the mineral-filled waters of the soil. From the bulb a few long, narrow and pointed leaves of a green-blue tint grow to a height of about a foot, and in their midst arises the long hollow tube of the flower stalk.

When the spring sunshine breaks through the yet bare branches of the trees, the bud bends forward, making an elbow at the top of the stalk. As the bud opens, it unfolds its six long pointed petals of deep warm yellow, revealing the golden trumpet within, fretted around its mouth. In the heart of the trumpet stands a ring of six golden-anthered stamens, with a pistil in their midst having a triple-headed stigma.

The shining gold of this crown-like flower attracts the early bees, who find an easy landing place in the broad




mouth of the trumpet. In the evening, when the moths are on the wing, and the golden crown is lost in the shadows, the bright yellow petals still gleam with ghostly whiteness and bring moths to the stamens and pistils, until the darkness falls and the flower closes for the night.

The daffodil is the poet's flower ; it is also a flower of commerce to no small extent, for it is one of those popular " cut flowers " which are marketed for the drawing-rooms. In January and February every year nearly the whole population of the Isles of Scilly are employed in gathering daffodils and narcissi from their farms ; and when I was in Scilly last August, the old seaman who used to row me to the " Bird Island," Annett, was already at work every day making wooden boxes in which the flowers were to be sent to London in the New Year.

Old Stephen Hicks of St. Agnes, now 75 years of age, spends many hours in the wet fields in January, February and March, when men, women and children are deep in

the long, dripping grass all day, cutting the daffodils which are just in bud or on the point of opening. Then the little steamer *Scillonian* ploughs the rough waters beyond Land's End, laden to capacity with hundreds of thousands of blossoms which soon will grace the flower-shops of London *en route* to the drawing-rooms.

The daffodil is cultivated in parts of the United States, especially in the east. Other plants belonging to the Amaryllis family include the following genera.

**Daffodil** (*Narcissus*). Many species of this beautiful genus are cultivated in gardens, and fresh " varieties " are being constantly produced. The genus is divided into two classes (*a*) the species bearing one flower on each flower-stalk, and (*b*) those bearing two or more flowers on one stalk. The blossoms vary from white to golden yellow. This genus includes the species called *jonquil*.

**Snowdrop** (*Galanthus nivalis*). In the earliest days of the year, often in January, a pair of long straight narrow sea-green leaves sprout from the soil. A little later comes up a single stem which bears a single spathe, which, opening, reveals three white sepals, three smaller petals of white, lined with green. Inside are six stamens and a slender pistil. The snowdrop is now rare among wildflowers in Britain, though much favoured in gardens. It is found in Europe and America.

**Snowflakes** (*Leucojum*). Though a separate genus from snowdrops they are very closely allied to the latter and are similar in many ways. They flower much later in the year.

**Agave.** A genus with about 150 species, most of which are desert plants, though one species is cultivated—the so-called " American century plant." The species called *Agave sisalana*, a native of Mexico, Central America and the West Indies, is an important commercial plant, yielding sisal hemp, a strong fibre used to make rope and string. The

twine used in the United States post office is made of sisal hemp. *Henequen* is a Mexican species of fibre-producing agave. The two best known Mexican drinks, called "pulque" and "mescal," are obtained from certain species of agave.

**Amaryllis.** The genus which gives the name to the family. The true species of Amaryllis has beautiful red scentless flowers, which gleam with gold tints in the sunshine. It is a native of South America, but is now cultivated in North America and in Europe. There are several species of Amaryllis, among which we may mention *amaryllis belladonna*, known as the belladonna lily, which has sweet-smelling rose-coloured flowers; and *amaryllis sauniensis*, which is called the *Guernsey lily*.

The amaryllis family is closely allied to the lily family. Many of the 100-odd genera and the 1,000 species are called lilies. This is the case with the *Amazon lily*, the *spider lily*, the *zephyr lily* and several more belonging to the *Amaryllidaceae*. For this reason it is necessary to know a little bit about the structure of flowers and plants, their popular names often being more misleading than informative.

The chief difference between the lily family and the amaryllis family is in the fact that the liliaceae have the ovary (seed-case) inside the enclosing petals of the flowers, while the Amaryllidaceae have the seed-case below the flower at the top of the flower-stalk. A slight difference, but enough to show that they are two families, not one.

## IRIS FAMILY

(*Iridaceae*)

The iris family, too, has its seed-case (ovary) below the flower, at the top of the flower-stalk; and the main difference between iris and Amaryllis is that the iris family has but three stamens instead of six. There seems also to be more variety in the shapes and arrangements of petals in the iris family, which is a large family of about 1,000 species in

60 genera. There is certainly more variety of colour, at least in the genus which has given the family its name.

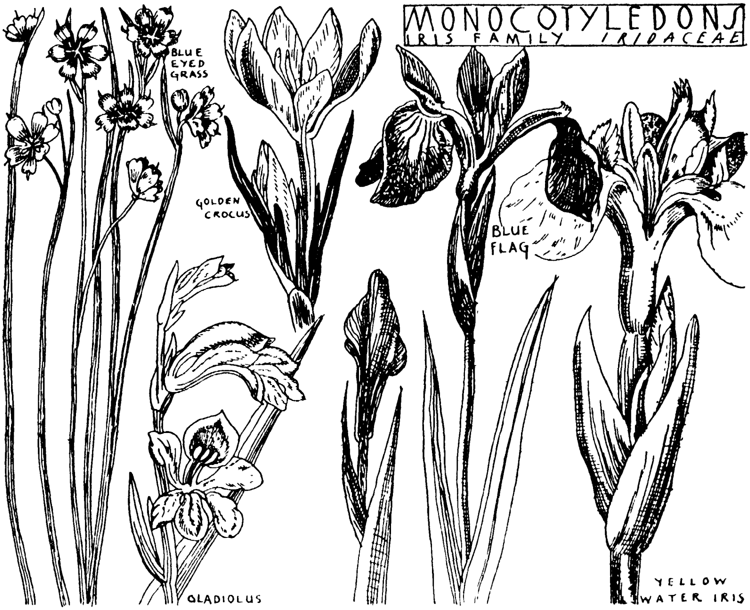
**Iris.** The name iris comes from the Greek word for a rainbow ; and " rainbow " is certainly the best name for this exquisite flower, which springs up in bewildering colours in 200 or more species.

Take the common purple iris, sometimes known as the blue flag. This flower is very stately as it stands erect above long, narrow, pointed leaves like giant blades of grass. It stands upon the top of a stout, straight green stalk. It is violet-blue with lines of white, green and yellow.

At first there seem to be nine petals, folded and curved this way and that like waves breaking and rebounding at the foot of broken cliffs. Really, there are but three petals of the iris. The outer three " petals " are truly the sepals : they droop back gracefully away from the centre of the flower towards the outer world. They are soft and velvety. The next three are the true petals, and they rise up straight and curl over slightly at the tips, inward towards the lovely heart of the flower, where we see what appear to be three petals springing from the very centre, curling outward like paler violet-hued petals. These are not petals at all, but the three-branched head of the stigma, each branch of which overhangs and protects one of the hidden stamens which grow around the pistil.

Well might our ancestors imagine that this most lovely pattern was designed for our delight ; but the story of this grouping of sepals, petals and stigma-branches, is as practical as the development of the cafeteria.

The iris is a flower greatly loved by bees, for much sweet nectar is stored at the base of each stamen. If we watch a bee alight upon an iris we shall soon conclude that the colour markings, the lines of white, green and yellow, are actually signposts to direct the bee to the store of nectar : they are indeed called honey-guides. Landing upon a honey-guide and proceeding in the direction of the nectar, the weight of the insect's body presses down the petal and




an opening appears between the petal and the pistil. The bee thrusts in his body and shoots out his tongue to collect the nectar. In doing so, his body brushes against the stigma and presses it open. His back is covered with pollen from another flower, and this pollen is brushed off on to the part of the stigma which is designed to receive it and pass it down to the ovary to fertilise the eggs. Just below the stigma the bee rubs against the anthers and gathers a fresh supply of pollen. As he crawls backward out of the flower, he presses the stigma back into place, so that none of the flower's own pollen can reach the stigma, and in this way the danger of self-pollination is avoided.

The iris is the "flower-de-luce" of Shakespeare, the *fleur-de-lys*, emblem of the monarchy of France; but this marvellous contrivance, adapted so perfectly to the visits of the bee from flower to flower, reveals that this elegant blossom is also an engineering achievement in every sense of the word, not a mere ornament to decorate the world.

The various flowers of field and garden vary in their adaptability to insects: some seem more happy-go-lucky than others; but a vast number of them are every bit as careful as the iris. Naturally, we cannot describe in any fullness the perfection of the iris, nor can we deal in any way with the wonderful insect-adaptions of most flowers; but, happily, these wonders are free and abundant for anyone to observe —for anyone, that is, who has the spirit of adventure in him and the love of life.

Having leaned just once over the waving rainbow-flower, and learned in brief outline the mere nature of an iris, we must pass on to a yet briefer glimpse of the species of iris and the genera of the iris family.

**Yellow Iris** can be found by bogs and marshes, beside streams and sometimes in streams themselves—great flaring yellow flowers. The leaves of this species are long and pointed, and their edges are sharp as swords. This golden flower springs out above the sword-leaves that guard it; and the red and dark yellow honey-guides that pattern the petals seem like little flames.

**Gladdon.** This is a smaller flower, closely resembling the yellow iris. It stands but half the height of the yellow iris, has softer, darker leaves, less rigidly erect. The flowers are a shade smaller than those of the yellow iris, and the broad out-curling sepals are blue-purple, the petals and stigmas yellow. This flower prefers dry places to wet, and is often found in chalk and limestone soils. If you bruise or break one of its leaves it gives off a not very pleasant odour, which reminds some people of roasting beef. For this reason it is called *foetidissima*, which means "most smelly": it is this smell which attracts certain species of fly by whom the flower is adapted to be cross-pollinated.

Other genera in the iris family include the following famous flowers:

**Crocus.** This early spring flower, which grows in clusters over the grass, and is often planted in rings round the trees, is one of the purest in design, like a small tulip. There are crocuses of many colours, lavender, lilac and yellow, some of two colours as in the striped lilac-and-mauve and the white-with-lilac-stripes. There is a deep purple variety and a pure white one. The crocus is a native of the Mediterranean lands and of the East, but is cultivated in gardens in Europe and America, where it has managed here and there to escape as a wildflower in certain woods. There is a species which flowers in the fall (autumn), the *autumn crocus.*[1]

**Gladiolus.** There are many species of this genus, a great variety of cultivated kinds being found in gardens in Europe, North America and South Africa.

This must conclude our brief glimpse of the iris family.

Beside the families at which we have looked, the class of monocotyledons contains a number of others. There is, for instance, the valuable order of SCITAMINEAE, which contains four families :

## BANANA FAMILY
(*Musaceae*)

## GINGER FAMILY
(*Zingiberaceae*)

## ARROWROOT FAMILY
(*Marantaceae*)

## CANNA FAMILY
(*Cannaceae*)

At least three of the above four families we could not well do without ; but since they are tropical plants we cannot

[1] The plant popularly known as autumn crocus belongs to the genus *Colchicum* in family *Liliaceae*.

deal with them in this book. Instead we pass on to the last of the monocotyledons, the family which many botanists consider to be the most highly developed of the class.

## ORCHIS (ORCHID) FAMILY

(*Orchidaceae*)

To many people the word " orchid " brings to mind a rich man's hot-house where weird foreign plants are carefully tended. There are, indeed, strange tropical orchids, orchids that live like parasites on the trees in the rain forests of Africa and South America, and grow petals of marvellous shapes and shades. Yet in our own woodlands and meadows and hedges we can find several species of wild orchid in the spring and summer.

The *early purple orchid* may be discovered between April and June, the *spotted orchid*, with delicate lilac flowers and veins of fine lines, may be found in ditches or moist heaths between May and July. One may also find the *twayblade*, with greenish-yellow flowers in a long spike, the *sweet-scented orchid*, the *bee orchid* and *fly orchid*. The last two curious wildflowers are rather rare, and resemble the bodies of bees and flies respectively. It is odd that they should imitate the insects in this way, since careful observation has shown that the fly orchid is seldom, and the bee orchid never, visited by insects. Are the insects alarmed at this close resemblance to themselves? These orchids are forced to rely on self pollination, since they are not adapted to wind pollination; and this perhaps accounts for their rarity, as we have seen that self pollination weakens a flower.

There are, however, between 40 and 50 wild species of orchid to be found in our land, so that a short walk anywhere in May and June should enable us to find some.

Every orchid consists normally of fifteen parts—three sepals, three petals, three stamens, three pistils, three carpels: yet what variety the different genera and species of the orchid family exhibit, not merely in colouring and marking, but also in shape! In many species, for example, one


of the petals is greatly larger than the others, and is the most highly coloured and the most strangely shaped : it will often rise up and hang over like a sheet of water falling over a cliff. Even in such parts as the stamens great variations occur. In the noblest of the British wild orchids, the pretty *lady's slipper*, two stamens are fully developed and the third never grows pollen, but stands, a barren column, between the other two.

The ordinary purple orchid (or orchis) of the meadows in May and June has a purple-tinted stem, glossy green leaves spotted with purple, pale lilac spikes, reddish-purple petals, with one larger overhanging petal spotted with white. Each flower rises from a twisted ovary that serves as a stem to support the flower and has a long spur turning upwards.

Other interesting wild orchids which may be found by the wayside in the summer months include :

**Yellow-Fringed Orchid** (*Habenaria ciliaris*). Has one large petal forming an oblong, drooping lip an inch to an inch and a half long, its edges fretted. The two smaller petals also have fretted edges, and are smaller than the sepals which are oval or almost round, two spreading sideways, the third in the centre forming a sort of hood over the flower. The flower is orange-yellow.

**Lady's Tresses** (*Spiranthes*). Small flowers on a twisted spike. There are several species, found over the greater part of the globe.

**Coralroot** (*Corallorhiza*). Sepals and petals nearly alike, except for the big centre petal which hangs out like a tongue. Brown or yellow flowers.

**Helleborine** (*Epipactis*). A genus containing very few species. Purple-brown or pale, almost white, flowers, sometimes tinged with red.

Among other species of common orchid are the *bog orchid*, *fen orchid*, *bird's-nest orchid*, *green-winged orchid*, *military orchid*, *lizard orchid*, *frog orchid*, *butterfly orchid*, *man orchid*, *musk orchid*, *and spider orchid.*

One thing to note about orchids is that each grows from a *tuber* ; but we will give an account of tubers in another chapter. (See Chapter IX.)

# CHAPTER VII

# THE FOREST

IT WAS ONCE BELIEVED that the spirit of the oak tree was a beneficent spirit for man. When the oak tree was leafless in the winter, and the mistletoe bough hung gay and green with berries and leaves upon the bare oak tree branch, it was believed that the spirit of the oak had taken refuge in the mistletoe. Therefore every mid-winter the mistletoe was cut off and brought into the house in order that the tree spirit might bless the people with abundance.

To-day we carry on this old tradition. We hang mistletoe over the door at Christmas time, though we have long since ceased to believe in the tree spirit, and we no longer have faith that the mistletoe bough will bless our homestead. We hang up the mistletoe because it looks bright and seasonable, the smooth leaves and pale berries, beside the bright red berries of holly and the shining prickly holly leaves.

But many men in many ages have worshipped the tree spirit ; and of all trees none has been so often worshipped as the oak, the massive oak, straight of trunk, powerful of branch, long of days.

> "*Jove's own tree*
> *That holds the woods in awful sovereignty.*"[1]

The oak begins its long life in the fruit we call an *acorn*. Before the acorn, the pollen-bearing flowers hang down singly on thread-like pendulous stalks in tassels from the

[1] Virgil, *Georgics*.

youngest twigs. These tassels of many scores of flowers are called catkins, and all trees that bear these tassels are grouped by some botanists into the great Catkin family, which includes hazel, birch, alder, chestnut, beech, poplar and many more. These catkin trees may have been the first of the true flowering plants to appear on the earth, following the conifers.

The pollen from the catkin flowers of the oak is carried by the wind to the seed-bearing flowers, which are also tiny and are borne separately or in clusters from the basis of the young leaves in the spring. Here the acorns develop. Some species, like the white oaks, mature their acorns in a single season ; others, like the black and the red oaks, require two years.

Within the acorn the tiny stem and the tiny root of the baby oak has two seed-leaves, thus announcing the dicotyledon class of plants. These seed-leaves are full of starchy food made by the parent tree and stored in the cells of the baby plant as a legacy with which to begin life. When ripe, the acorn falls.

Maybe it is blown some distance. Perhaps it falls into a stream and is carried to a meadow far away. Perchance it is picked up by some bird, some passing mammal, a squirrel, perhaps : however it be, this acorn finds itself one warm spring morning lying on the ground. The sun stirs the living cells to work. A root splits the acorn-shell below and dives down into the soil. A shoot breaks through the upper surface of the shell and strains upward towards the light.

When the young oak tree consists of nothing but an inch or two of root and shoot, how does it gain its energy ? It has not grown any green leaves of its own and it therefore cannot make use of the sun's energy for the manufacture of food. It has to rely upon the starch-food in the seed-leaves (cotyledons), stored for it by the parent-tree. As soon as this " seedling " oak has put forth a few green leaves and its roots have begun to absorb mineral-filled water, it has commenced its own independent life, and we call it a sapling. The leaves of the sapling also reveal to us the fact that

it is not a monocotyledon. All monocotyledon leaves, we remember, have parallel veins—veins running from the axil of the leaf to the tip. The veins of dicotyledon leaves branch out across the leaf and end up freely at any point in the leaf's surface, or anywhere at the edge of the leaf. This produces in dicotyledon leaves a great variety of vein-patterns and a great variety in the shapes of the leaves.

Year after year the young oak tree grows, each part growing in proportion to the rest. As the branches spread and more leaves unfold, more water is needed, and longer roots push their way beneath the soil in search of water.

A curious fact about oak tree roots is that they often have very few root hairs : sometimes none at all. How, then, do these roots suck up water? Certain fungi have undertaken the task of being "drawers of water" for the oak tree. These fungi live on the roots of many trees—orange, maple, hickory, birch, beech, larch, and others, as well as on oak—and they put forth hair-cells which suck up the water and pass it on to the tree. In return for this service they share in the tree food which comes down from the leaves to the roots.

The oak tree, then, may have parasites upon each end—fungi upon the roots, mistletoe upon the branches. It is important to note that mistletoe is not a fungus. Having green leaves of its own, it can take in carbon dioxide and can capture and use the strength of the sun in the manufacture of food. It relies upon the oak tree solely for sap, sucking much of this mineral-filled water away for itself, and often seriously weakening the oak. Mistletoe has caused great damage in the south and west of the United States, especially to the magnificent white oaks of California.

In Britain, mistletoe grows but rarely upon the oak, a fact which has been known since the time of Pliny, who described the worship of the mistletoe-bearing oak by the Druids. In Britain the mistletoe prefers to grow on apple trees, hawthorns, sycamores, limes, poplars, firs and several other species of tree.

We see that in dealing with the oak we have perforce to

mention other trees—other trees that have fungi upon their roots, other trees that entertain the mistletoe upon their boughs. It is not surprising that we should have to do this, for trees of many sorts live together and affect one another.

" Somewhat as men have come together to live with one another in villages and cities, rather than pursue solitary existences, so trees over large areas are found growing in close contact with their neighbours. These associations of trees we call forests.

" But it would be a mistake to think of a forest as merely a piece of land with trees growing on it. . . . Every tree is affected for good or bad by the trees that surround it."[1]

There is war among the trees of a forest. They fight for soil and sun, root against root, branch against branch ; weakly trees in most cases soon have the soil water sucked away from them by the roots of stronger trees, and the life-giving light of the sun cut off from them by the spreading branches of their stronger and successful rivals. Then these weakly trees die and fall and are taken to pieces ; and the raw materials of which they were made are set free to enter into and increase the strength of the conqueror trees.

Because of this struggle among the trees you will find as a rule that every forest and wood has only a certain number of species of tree—often only two or three kinds, sometimes five or six, rarely more.[2] These two or three kinds will usually be species that live well together, like aspen, poplar, and birch, or pine, maple and oak.

The oak is generally king of the woods in which it dwells, " but a hospitable king, that . . . flings its arms widely, in a protecting manner that allows the life-giving light to penetrate to the ground and sustain weak flowering herbs as well as sturdy shrubs and trees less vigorous than itself. . . . The oakwood, in any season, at every turn of its devious tracks, offers us something fresh : there are bosky dells and

[1] C. L. Pack and Tom Gill, *Forests and Mankind*, p. 25.

[2] Of course this is true only of forests in the temperate zone. The tropical forests have vast numbers of species.

flowery glades" in summer; in winter "the flowers are wanting, their places are taken by abundant fruits, by many-hued fungi, the rich filigree of the lichens on the trunks and the fine velvet of the mosses underfoot."[1]

When we leave the glaring sunlight of the open fields, and entering the still dark woods, wander amid the community of the trees, we feel that we are in a strangely different world. On all hands we feel there may be lurking woodland creatures, creatures who never or rarely come out into the open, birds and beasts whose homeland is the woodland, vegetation adapted solely to a life-cycle in the semi-gloom under the trees.

Small creatures like squirrels, badgers, stoats and weasels, make their home in the English woods. Such mammals are the aristocracy of the woods; beside them, there are hundreds, even thousands, of forms of life, ranging from birds and vegetation down to microscopic fungi and bacteria, which are exclusive to the woods. The population of even a small wood is to be reckoned in millions.

If a forest is burned down, or if it is cut down by man, millions of creatures are driven out into the open, or left exposed to die, as millions of men would die if a city's buildings were all to crumble and vanish suddenly, leaving the inhabitants roofless and foodless.

The soil of a forest is different from the soil of open fields and plains outside. It supports different soil-bacteria, a different animal and vegetable life of its own. Even the climate of a forest is different from the climate of open spaces which may be but a few miles away.

A forested country is neither so hot in the day, nor so cold at night, as a land bare of trees, because (*a*) in the day the millions of leaves of thousands of trees will be slowing down the light-waves of the sun into heat-waves, as we saw in Chapter I. This captured heat goes to make the sugars and starches in the leaves, and this is carried to give energy to the cambium and the living bark, and even down to the roots, so that the whole tree is really a storehouse of heat.

[1] Edward Step, *The Harvest of the Woods: Autumnal Gleanings*, p. 81.

This heat has been taken out of the atmosphere during the day, so that during the day the atmosphere over a wood is colder than the atmosphere over a plain. But (*b*) you remember that the water sucked up from the soil by the roots of trees is given out into the atmosphere through the stomata of the leaves. This water is transpired all day long by millions of leaves in a forest, so that the atmosphere over a forest is far more full of water vapour than is the atmosphere over a plain. So when the sun sinks, and the rays of heat and light cease to fall, the open country cools rapidly, but the woods cool slowly and remain warmer all night, because the abundant water floating over them holds the heat. We say, therefore, that the climate of a forest or a wood is more *equable* than that of a plain or of open fields : that is to say, it is less subject to extremes of heat and cold.

These few facts are some of the reasons why a forest supports a different population from that of the fields. Nothing affects animal and vegetable life so much as heat and cold, wetness and dryness, and in these things wooded places differ markedly from open ground.

There are many other ways in which trees, living together as a wood or forest, create a special environment to which many creatures have adapted themselves : of all these things we cannot speak ; but we can hardly neglect the chief of them all, the tree itself.

The tree does not merely provide a nesting place for birds, a restaurant for squirrels, a shady city for the badgers and stoats, a firm foothold and water supply for fungi, and a special soil for special sorts of bacteria. The tree itself is the object of attack for many insects who could not live without trees : the bark beetle, for instance, who eats his way through the living wood, who lays his eggs in the heart of the tree, and then eats his way out by another route. The eggs hatch and his children eat their way out, tunnelling through and weakening the tree, so that sometimes the tree falls, sometimes it withers and dies because the bark beetles have eaten through the sapwood, which prevents the sap rising to the leaves.

Then there are leaf-eating insects, which include certain butterflies and moths, as well as insects belonging to the same families as the bees and wasps. One of the worst of these leaf-eaters is the gypsy moth, who will often eat away all the leaves on a large tree, leaving the tree as bare in midsummer as in midwinter. Happily, however, there is in the axil of every leaf a bud which remains in readiness for just such a catastrophe as a raid by gypsy moths and many a tree has saved its life by opening up all these buds, and so growing new leaves, when the gypsy moths have eaten all the regular leaves.

There are numerous other dangers that surround the life of a tree, some of which the tree is prepared to meet, others against which it is defenceless ; but things are not so bad as they look, because these tree enemies are not a mighty organised army intent on destroying the tree. On the contrary, the tree-enemies fight among themselves. The birds eat the destructive insects : the insects eat one another's eggs, and, in some cases, one another (ants eat bark beetles and leaf-moths, for instance). Also, as we have seen, there are parasites and fungi which have reached a just understanding with their " hosts "—that is, with the trees to which they cling, and to which they owe their livelihood —as the root fungi on oak and on other kinds of tree has done.

For, let us remember that a balance must be kept in nature if creatures are to survive. It is no good killing the goose that lays the golden egg, though many a hungry fungus has failed to learn that lesson, and has perished miserably with the tree it has destroyed. The place of that parasite fungus is taken by a saprophyte brother, that will feed on the dead trunk of the fallen tree.

When a tree falls, it's not an end to the forest. There are hundreds, perhaps thousands, of seedlings waiting around the roots for the old monster to crash over and give them space to grow. When a forest tree tumbles over dead, a hundred seedlings spring up in the open glade left by the fallen tree : for many months, perhaps for many years, these

saplings (as they speedily become) will flourish together—until the time when their roots begin to get entangled and their branches touch. Then the real struggle begins, and the strongest and healthiest tree will win out and grow up to full tree-hood in the space vacated by the old log that was once a tree but is now half-buried and decayed away, amid the undergrowth.

So life goes on. . . .

# CHAPTER VIII

# TREES AND SHRUBS (I)

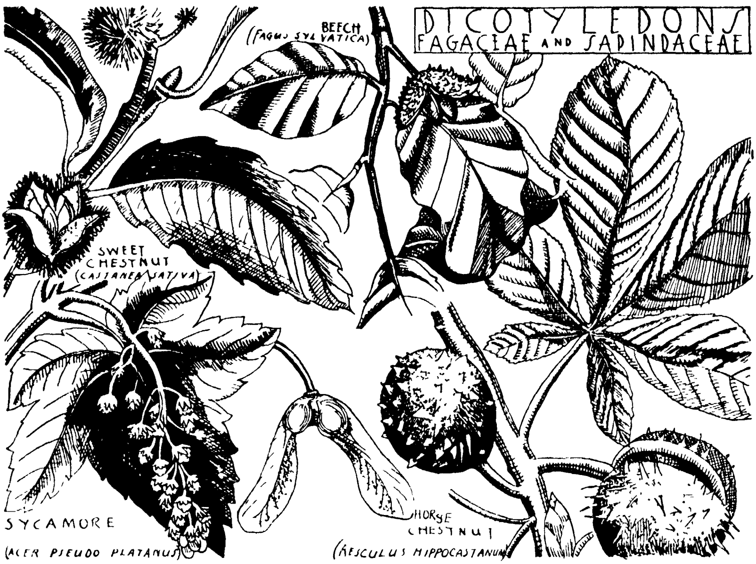
## BEECH FAMILY

*(Fagaceae)*

THIS FAMILY has five genera, of which 350 species are trees. It is the family of the oak, which we have been examining, and of the two following important trees, as well as of many others in all parts of the world.

**Beech** *(Fagus sylvatica)*. The leaves of the beech tree when they first unfold are a bright yellow-green. As the summer approaches the colour deepens and the surface becomes glossy. In the autumn the green shades give place to tints of yellow and brown. There are species of beech which are native to England, to Europe, to North America, and to Asia. The fruit of the beech used to be known as "buck," and it is from this word that the county of Buckingham in England obtained its name, on account of the beech-woods there. The beech, like the oak, lives to a great age. There is a beech 800 years old in Windsor Great Park. The bark of the beech is thin and smooth and purple-grey in colour. As a beech ages, lichen and moss gather about the bole turning it green.

**Purple beech.** This strange and beautiful variety has been found growing wild in Europe. The legend of the origin of the purple beech is given in Scheuzer's *Natural History of Switzerland*, published in 1708. It is related that five brothers murdered one another at the spot where the




first five purple beeches afterwards sprang up. The purple beech is what is called a " sport " from the common green beech. In the spring the purple beech has delicate light red-coloured leaves, becoming a deep purple in the summer. In the early autumn the leaves almost entirely lose their purple colour, and change to a dark dusky green. The buds, young shoots and fruits are purple in colour. This colour is caused by pigment cells which " mask " the green chloroplasts, in the same way as a man with a corked face masks his pink skin. The green colouring is present in the purple beech, as it is in brown seaweed, and in every true plant, for the green colouring is the chlorophyll which captures the energy of the sun. If you boil a leaf of purple beech, the purple mask will disappear and the plant will become green.

**Copper beech.** This is a sub-variety of the purple beech, with leaves of a paler colour. There is also a sub-variety of copper beech in which the leaf is edged with pink

when young. These varieties and sub-varieties of the purple beech are very beautiful and are used a good deal by landscape gardeners, who propagate the trees by *grafting*. The purple and copper beeches sometimes seed themselves, but not always : they seem to need some encouragement to continue and spread their kind.

The process of grafting is a well known and ancient practice. It is one of man's strangest and greatest achievements in the cultivation of plants. It consists of cutting a twig or branch off one growing tree or shrub and binding it on to the branch of another growing tree, so that the two grow together and become one plant.

Some plants give of their best when grown on roots which are not their own. Certain varieties of roses have to be grown on the wild dog rose. Sweet apple varieties are grown on the wild crab apple. Cherries, plums, pears and many other orchard fruits are grown on the stems and roots of wild varieties. In this way, too, is the copper beech induced to spread his kind, being grafted on the common green beech.

The secret of grafting lies in bringing the cambium of the cut-off twig or branch against the cambium of the rooted tree : the cambium, you remember, is the layer of cells which are ever active ; and when you cut off a wild tree at the stem and fit into it a branch of a cultivated tree so that the cambiums meet and join together, the vigour of the wild plant helps the cultivated one to produce its rich fruit in abundance. Men are constantly carrying out experiments in grafting in order to increase the fruitfulness of their orchards and the beauty of their trees.

**Chestnut** (*Castanea sativa*). In good soil and in right surroundings the chestnut may grow to a bigger size and live to a greater age than either the oak tree or the beech. (When any tree stops growing it stops living, so that older trees of the same species are always bigger than younger trees.)

The chestnut has egg-shaped leaflets 8 or 10 inches long,

of a rich green colour, with a shining surface, their edges cut into long pointed teeth. It bears small flowers in yellow catkins, about six inches long, which hang from the axils of the leaves. The upper part of the catkin consists of male flowers, each with a number of stamens held in a calyx of *five* or *six* green leaves. Female (or pistillate) flowers grow on the lower part of the catkin, two or three flowers together in a bunch in a cup of prickly little leaves that have wavy edges. Each flower has a tapering ovary, from the top of which spring 5 to 8 spreading stigmas. When the ovum (egg) has been fertilised and the seed begins to grow, the calyx of leaves grows round it, curling and closing over the ripening seed ; and as the season advances the enclosing leaves harden and thicken and their spikes lengthen, forming a spiky overcoat for the seeds.

The sweet chestnut is not so well known as the " horse chestnut," whose prickly " burrs " are so common, and whose fruit, called " conkers " by English schoolboys, is used in that frantic game in which it is every boy's ambition to maintain unbroken a champion chestnut from one season to the next. (Has it ever been done ?) Actually the horse chestnut is a tree entirely unrelated to the sweet chestnut, and does not belong to the Fagaceae at all.

## THE SOAP BERRY FAMILY

(*Sapindaceae*)

This family has about 150 genera and over 1,000 species, most of which are tropical shrubs and climbing herbs. Only one member lives in our own land.

**Horse Chestnut** (*Aesculus hippocastanum*). The fruit of this tree resembles the fruit of the chestnut, which is, I suppose, why it is called horse chestnut, though actually the two trees have nothing whatever to do with each other. Whereas the fruit of the sweet chestnut is eaten throughout the land, the horse chestnut is non-edible. The horse chestnut is, however, a more beautiful tree than the sweet chestnut.

The leaves are great star-shaped clusters of leaflets springing from a bright green stem which forms their hub. Five, six or seven of these leaflets swing around the green hub all the summer : these leaflets, each are about eight inches in length, have grooved or notched sides and are beautifully and deeply veined. The beautiful scented flowers of the horse chestnut grow in dense pyramids, pointed skywards, each growing from a circle of leaves. Each flower of the pyramid of flowers is shaped like a bell and measures more than an inch across, and generally has four petals. The petals are creamy white, with spots which are at first yellow, but afterwards turn pink. The lower flowers on the pyramid are male and open first, the flowers on top are at first female, with pistils only, but later develop also stamens with pollen-covered anthers. The horse chestnut flowers are adapted to be cross-pollinated by bumble bees. Most of the big woodland trees are wind-pollinated.

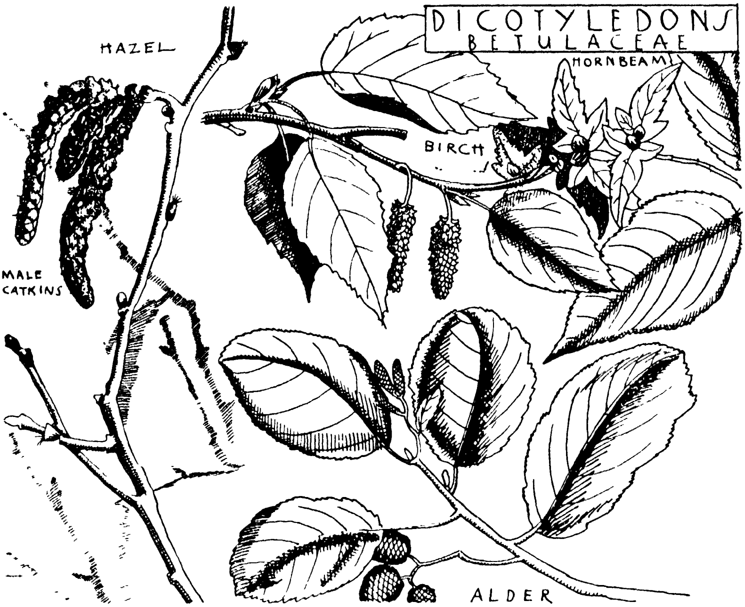
The other members of the soap berry family are tropical and do not come within the scope of this book, though the *akee*, a tropical fruit tree of Africa, which is cultivated in Jamaica, sometimes produces fruit in hot houses in our country.

## BIRCH FAMILY

(*Betulaceae*)

The many species of this important tree family are grouped into six main genera, all of which have many common features in the form of their wood, leaves and flowers. There is only one genera of Betulaceae which is not well known in all the northern continents. The stranger is *Ostryopsis*, a genus with a single species growing in eastern Asia.

**Silver Birch** (*Betula alba*). The white or silver birch grows throughout the greater part of Europe, and also in Asia Minor and Siberia, forming extensive forests, especially in Russia, where it is one of the most widespread and generally useful of trees. In ancient Rome the fasces of the lictors




—from which the Fascist Government of modern Italy takes its emblem and title—were made up of birch rods.

" The Lady of the Woods," as Coleridge christened the birch, has a smooth and silvery bark. The small twigs of the birch have a polished surface and are purple-brown in colour, but the larger twigs are copper or chestnut coloured. Catkins of both sexes grow on the same tree. The female catkins are the smaller of the two at first, are green in colour, and grow upward from the twigs. The larger male catkins hang down from the ends of the twigs : they generally grow in pairs, and are reddish brown in colour. They are formed in the summer and do not develop fully until the following year. About April the hanging male catkins of the birch become dark crimson, the scales separate and expose the two stamens of each flower, which has but a single sepal, no petals. The upstanding female flowers then open out, and are seen to consist of two or three flowers having neither sepals nor petals, but simply a bare ovary

with two pistils. After the wind has carried the pollen to the stigmas of the pistils, the female catkins close again, and swell into cone-like forms which hang down from the twigs. At this stage each female catkin measures about half an inch in length, and at the end of the summer, when the seeds are ripe, it splits up, shedding the seeds and scales and leaving the axis bare. The seeds are flat and are provided with a small pair of wings.

The leaves of the birch are triangular or diamond shaped, and are arranged alternately round the shoot. In the spring they are bright yellowish green and are very wrinkled, but after a time they flatten out and become darker in colour. Long leaf-stalks enable them to twirl and flutter in the breeze. The bark of many species of birch is of greater use to man than the wood, which is not very durable ; and a most thrilling story could be written of the part played by the birch bark canoe in the exploration and development of the North American continent. This canoe is made of the bark of the paper birch (*Betula papyrifera*).

**Hazel,** or **Hazelnut** (*Corylus avellana*). The hazel is a small tree with brown bark, mottled grey, with leaves roundish and heart-shaped, from two to four inches in length. The flowers appear before the leaves. Everyone knows the drooping yellow male catkins called popularly " Lambs Tails " ; but you might have trouble in finding the female flowers, which are mere clusters of crimson stigmas on thread-like pistils, perched on the tips of specially adapted leaf buds. When the true leaves open they are covered with a fine down of silvery hairs which disappear gradually as the leaf grows older. The fertilised flower-eggs (ovules) develop in the summer into little clusters of nuts, each set in a cup of stiff feathery leaves, or bracts. The nuts ripen and fall about October. " Filbert " is a name generally given to the oblong nuts of certain species of hazel. The round nuts of other species are called " cob nuts." The Constantinople hazel (*Corylus coburna*) is a large forest tree

producing small nuts from which are grown saplings on which are grafted European varieties of hazel.

**Alder** (*Alnus glutinosa*). This tree may grow in a great variety of ways. Perhaps it will rise up with straight trunk to a height of 60, 70 or even 100 feet and send out uplifted branches like the arms of the Arabs when they praise Allah. Or the alder may spend its life squatting down like a shrub, with no trunk to speak of, a mere bunch of branches springing from a boulder of wood. However it grows you can be sure of finding the alder near water, never on dry uplands. It loves marshes and wet fields, the banks of streams and rivers, and ground that is now and then flooded.

The common alder has a black bark, short-stalked roundish leaves, wedge-shaped at the base, with slightly notched edges. The stout red male catkins are from 2 to 4 inches long. The female catkins are less than an inch long and are rather brown than red. The male catkins, having shed their pollen, drop from the tree. The females remain and become woody cones in which the seeds ripen slowly. The seeds are not shed as a rule until next spring.

The common black alder is a native of Britain, North Africa and North Asia, and this curious distribution is paralleled by that of its brother the grey alder (*Alnus incana*), a native of North America, parts of Europe (not Britain) and Kamchatka. The grey alder has rather more pointed leaves than the black alder. The wood of the alder is very durable in water and is used all over the world for bridge piles, quays, and breakwaters.

**Hornbeam** (*Carpinus betula*). The hornbeam is sometimes mistaken for the beech, which it resembles in many ways. The leaves of the hornbeam, however, are of rougher texture than those of the beech, their edges are doubly toothed, and they are broader at the base. The two kinds of catkins are very like each other, but, as in the birch, the male catkins hang down whilst the female grow up until they are pollinated. The fruit of the hornbeam consists of a

small brown nut nestled into the axil of a large three-pointed leaf. When this leaf falls, the nut is carried with it, the leaf acting as a sail or kite to carry the nut as far as possible from the parent tree.

## WILLOW FAMILY

(*Salicaceae*)

The name of this family is said to be derived from the Celtic *sal*, " near," and *lis*, " water," on account of the love of moisture shown by these trees. There are but two genera, the genus of the willow and the genus of the poplar.

Who has not seen rows of poplar on a river bank ? They form the characteristic scenery for miles along many of the great rivers of the earth ; but the willow is an even more persistent inhabitant of the river's brim.

**Willow** (*Salix*). There are more than 200 species of willow all over the world, varying from willow plants a few inches high to trees 140 feet tall. At least four species are found in Britain, the white willow, the crack willow, the Bedford willow and the sallow. The *white willow* is so-called because the leaves reflect the light from their silk surfaces, glittering like the surface of water. The leaves are longish egg-shaped, the twigs olive-coloured. There is a variety called *golden willow* which has yellow-red twigs. The *crack willow* gets its name from its brittle wood. The leaves of the crack willow are lance-shaped, three to six inches long, with toothed edges. The leaves of the *Bedford willow* are more slender and taper to a point, and are smoother on both sides than the leaves of the crack willow. The *sallow* shows more variation in leaf form than the other three willows we have mentioned. Sometimes sallow leaves are almost round, or they may be thin and long, and they vary from 2 to 4 inches in length.

The willows are catkin trees. The catkins of the *glaucus willow* are soft and silvery and are frequently cut off in the spring and brought into the house for decoration.

These sprigs are known popularly as "pussy willows." In all the willows the male catkins are borne upon one tree, the female catkins upon another, and in nearly every species the willows are wind pollinated. In the earliest days of spring—often, indeed, before winter is gone—you can discover swarms of bees and moths visiting the sallow-blossoms in the woods. The sallow, like most of the willows, and like many other sensible trees, flowers before its leaves are out, so that the mass of leaves does not get in the way of the pollen which is being transferred from tree to tree.

**Poplar** (*Populus*). The poplar is not such a widespread tree as the willow, and is hardly found outside the north temperate zone. There are about 30 species. The *white poplar* (*Populus alba*) has a greyish white bark which becomes deeply furrowed in old trees. Its leaves are nearly round, and have deeply waved edges : their upper side is dark green, their lower side is covered with a dense white down, as are the young shoots in the spring. The *black poplar* (*Populus nigra*) has a grey bark like that of the white poplar, and it seems to have got its name because of the absence of white down from the underside of its leaves and young shoots. The leaves are otherwise very similar to those of the white poplar, but the catkins are more loosely built, not being packed so stiffly with little flowers.

**Aspen.** The aspen belongs to the genus Populus (poplar) within the family Salicaceae. The aspen (*Populus tremula*) is a tall, fast-growing tree with slender trunk and grey bark, which becomes rugged when old. The leaves are rounded, toothed in the margin, slightly downy when young, later smooth : they are dark green on the upper surface, greyish underneath. As in the true poplars and the willows, the male and female catkins are on separate trees. The leaves of the aspen are on exceptionally long stalks which causes them to shiver and flutter in the slightest breath of air.

## OLIVE FAMILY

(*Oleaceae*)

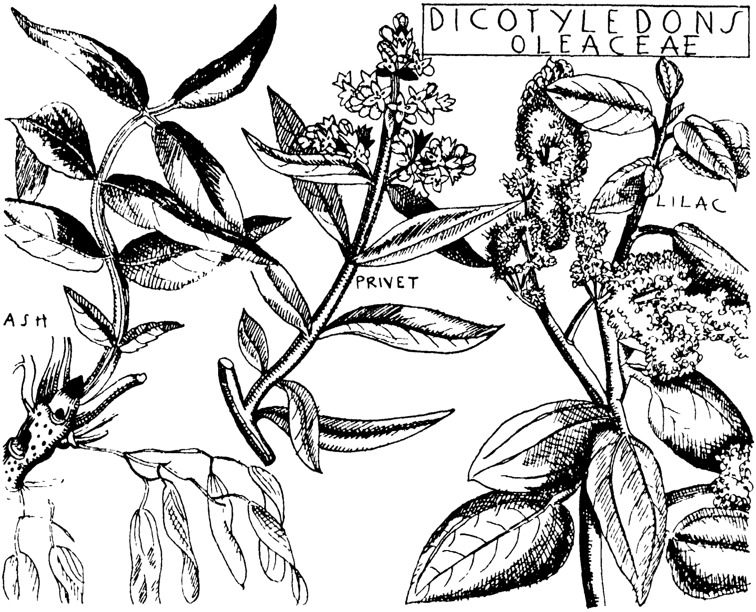
There are 20 genera in this family containing some 500 species.

Ash (*Fraxinus excelsior*). A native of Britain, of the greater part of Europe, and of some parts of Asia, the ash is a tall tree often reaching 100 feet, sometimes 150. A well grown tree may have a trunk growing for 40 feet before the lowest branches divide off.

In March or April, before the leaves appear, small clusters of reddish flowers grow on the end of the youngest twigs. These flowers have neither sepals nor petals, and usually male and female and "perfect" flowers—that is, flowers with both stamens and pistils—grow on the same tree and even in the same cluster. It sometimes happens that all the flowers on one tree are staminate one year and pistillate the next. When the leaves fall, the dry winged fruits, called keys, often remain hanging in bunches on the bare boughs. The leaves of the ash are large and the leaflets dangle in pairs on a slender stalk—sometimes as many as seven pairs on one leaf-stalk.

There are about 60 species of ash, of which we can but mention the curled leaved ash with crinkly dark green leaves, the American ash or white ash which has a lighter bark and paler green leaves than the common European ash, the red ash with deep brown bark, the black ash or water ash, the blue ash and the green ash which is a strong tree often planted by farmers to protect their crops from gales.

Privet (*Ligustrum*). Shrubs or low trees with evergreen or nearly evergreen leaves, about one inch in length, growing opposite each other on the stalk. The privet bears dense clusters of small white long four-petalled flowers, succeeded by small black globe-shaped berries. It is much cultivated in gardens and is grown in rows and clipped back




to form hedges along the roadways over many miles of our country.

**Olive** (*Olea europea*). In southern England the olive tree may be found flourishing here and there in gardens ; but a few hundred miles further south it begins to take its proper place as one of the most important, as it is one of the most interesting, of trees. It is cultivated all around the Mediterranean, and in several of the south-eastern States of America it forms an important crop. It is a pale blue-green tree, small, straggling, with thorny branches and notched gnarled bark ; it bears small white flowers and dark oval fruit ; but this book has no room in which to mention the value and extraordinary qualities of the olive.

**Lilac** (*Syringa vulgaris*). When May is come to the city and those small feathery trees in the front gardens unveil their bloom, there can be few people who will not sense the

presence of lilac and laburnum : the lilac tree, with pyramids of pale violet or white flowers growing upward, tall towering pyramids of quivering flowers, and the laburnum tree with chains of yellow blossom hanging downward, swinging in the wind ! Lilac and laburnum open the eyes of summer between them when May time comes round. Though lilac and laburnum belong to different families, it is meet to take them together, for they unfold together and grow together, and together shower their colour and their scent upon the grey mustiness of great cities. Lucky are those people who can plant lilac and laburnum in their gardens.

The lilac is a native of Europe and the colder parts of Asia. The flowers are small, set in a four-toothed calyx and have a funnel-shaped corolla. The leaves of lilac are heart-shaped and pale green.

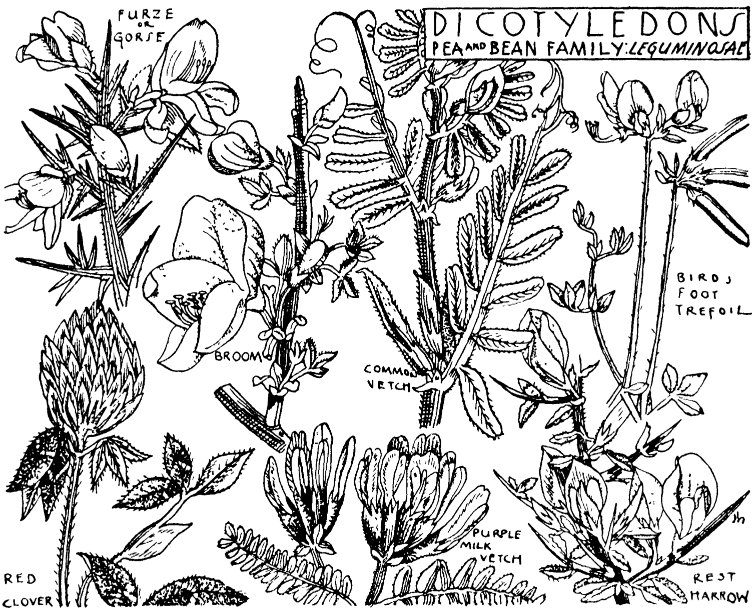
## PEA AND BEAN FAMILY

(*Leguminosae*)

This is the family of the pea and bean ; and we can only mention it here as being the family of the lovely yellow-flowered laburnum and the common broom and furze.

**Laburnum** (*Laburnum vulgare*). The laburnum is a native of the mountain forests of central and southern Europe. Ordinarily it is only a low tree of 20 feet in height, but it may reach 30 or more feet in favourable places. The pale round branches are clothed with leaves that are divided into three oval-lance-shaped leaflets, covered on the underside with silvery down. The long chains of golden flowers give place to pods containing many seeds.

**Broom** (*Sarothamnus scoparius*). This hairy shrub, two to six feet in height, is found on heaths and dry hillsides. The broom is a very beautiful shrub when in full bloom—in May or June—as it is then thickly covered with bright yellow flowers. They are exceedingly beautiful flowers, with petals an inch or more in length, shaped and arranged




rather like toy boats hinged together by the stern. The pistil and stamens of this flower are held to the " keel " of this " boat " in a state of tension like watch-springs. The pressure of a bee from above causes the sides and keel to fall with a sudden jerk, and the stamens and pistil to spring out. The bee is first dusted with pollen from below by short stamens, while pollen on longer stamens in the front part of the keel is thrown on the insect's back. Just before the longer stamens cast their pollen on the bee's back, the stigma jerks out and picks up pollen which the bee has brought from another flower. When the flowers fade their place is soon taken by the black seed-pods which explode when ripe and shoot out the seeds. The crackling of the exploding broom-pods is often heard on heaths in the hot summer days.

**Gorse, Furze** or **Whin** (*Ulex europaeus*). You can push your way through the soft yellow and green mass of the

sweet-scented broom without harm to yourself or your clothes ; but woe betide the unwary man or beast who blunders in among gorse ! For the gorse bushes protect themselves with rows of fixed bayonets ! These shrubs from two to six feet high also have yellow blossoms which are very similar to those of the broom. The flowers, however, are smaller, and are of a deeper yellow—glowing fire-points in the dense greenery of the shrub, fire-points scattered like golden stars across the green of the bush. Many of the smaller branches of gorse end in spines and many of the lance-shaped leaves have keen spines at their tips. The flowers are guarded by spines springing from the stalk, the points of the spines often protruding beyond the petals of the flowers. Many of the spines are two inches in length, the flowers rarely exceeding three quarters of an inch. These spines, however, are no danger to bees, which visit the flowers eagerly. Like the broom, the pods of furze burst with a cracking sound, and fling out their seeds far and wide. Gorse flowers earlier than broom, from February to April, and it is one of the few plants in the north temperate zone which flowers twice in a season, the deep golden stars appearing again in August and September, soon after the larger, paler blossoms of the broom have faded. Between them, broom and gorse keep many a moorland ablaze with colour for six months of the year. From these shrubs of the open hills and moors we pass once more to the stately dignity of forest trees.

## ELM FAMILY

(*Ulmaceae*)

This family contains 13 genera and more than 150 species.

**Elm** (*Ulmus campestris*). The finest elms at Windsor and in the Playing Fields of Eton are about 300 years old and 15 feet round the base of the trunk. You can go down the Long Walk at Windsor and see " the barky fingers of the elm " in as great perfection as anywhere. Yet magnificent

elm trees are to be found all over Europe, in parts of Asia and in North America.

The massive trunk of the common English elm is covered with a thick, rough and deeply furrowed bark. The lower branches in most elms are long and spread widely outward, those higher tending to grow upward. The heavy lower trunks have a dangerous habit of breaking off and falling. The leaves are oval-oblong with double-toothed edges. They grow alternately from opposite sides of the twig, and more often than not one side of a leaf is bigger than the other : that is to say, the axis or stem from which the veins spring is but rarely in the middle, resulting in lop-sided-looking leaves.

The flowers of the elm are " perfect "—that is, each flower has stamens and pistils. They are very small, a quarter of an inch or less across, two red pistils and five purple stamens, in a tiny cup of specially adapted leaves, clustered upon the tips of the youngest twigs. These flowers appear before the foliage unfolds. The ovaries of the flowers develop into winged seeds which fall from the tree in May or June. The wings are almost round and are of a papery substance and each carries a single seed in the centre.

The broad-leaved or *wych elm* is distinguished from the common English by having broader leaves which are more roughly toothed. The wych elm has a less upright stem, and does not bear those gnarled knobs which Shakespeare so aptly called the barky fingers. The wych elm, however, can live longer, sometimes attaining 500 years.

The elm seems to be a favourite tree for several forms of leaf-eating insect. The gypsy moth will always make a special set for the elm, and the caterpillar of the large tortoiseshell butterfly feeds upon elm leaves. There is even a special elm insect, the *elm-leaf beetle*, whose depredations are always feared by those who take pride and joy in this noble tree.

**Hackberry** (*Celtis occidentalis*). The hackberry is a middle-sized tree resembling the elm in many ways. It is

generally a smaller tree than the elm, its bark is rougher, and its branches open out more horizontally. The leaves are rather egg-shaped, but they taper to a long point at the tip, and narrow down also at the base where they grow from the stem. The hackberry has soft filmy flowers which open before the leaves are out. The fruit of the hackberry is oblong, one half to three quarters of an inch in length, reddish or yellowish in colour in the summer, turning dark purple in the autumn : it is sweetish and is much eaten in the United States. The seeds contain an oil which is not unlike almond oil.

## LIME FAMILY

(*Tiliaceae*)

This family is mostly tropical, containing in our own land but one tree of note.

**Lime** (*Tilia platyphyllos*). Linden is the old name for the lime, the word " lind " being the Anglo-Saxon for smooth, a reference to the smooth bark of the tree. The lime or linden is a favourite avenue tree for parks and cities in the old world as well as in the new. The lime-trees in St. James's Park in London are supposed to have been planted at the suggestion of John Evelyn the famous diarist, about the year 1660. He greatly admired " Tilia, the lime-tree, or linden." The limes of the famous Unter den Linden in Berlin do not compare with many avenues of limes in England, but the naming of the avenue reveals the respect in which they are held as a suitable and shady city tree.

The lime has a straight trunk sixty to a hundred feet, with long slender uprising branches, in spring bearing long-stalked greenish yellow flowers, in summer dangling collections of round nuts. The leaves, of a soft pale green colour, are heart-shaped, with toothed edges. They hang loosely and flutter freely from the long widespread branches. In autumn they turn yellow, falling early.

There are nearly thirty species of lime.

## MAPLE FAMILY

(*Aceraceae*)

A small family which botanists used to regard as a group within the Sapindaceae. Two genera are known in our land.

**Maple** (*Acer campestris*). Maples have five pointed leaves growing opposite each other from the stem. They have a peculiar *two-keyed* fruit (see illustration p. 239). The common or field maple is a small tree bearing greenish flowers in dense long hanging sprays. It is found in woods, thickets and hedgerows in many parts of Britain, Europe and America. The *sugar maple* is the far-famed tree whose leaf is the emblem of Canada. It is found mostly on the western side of Canada, and in the United States from Maine to the Gulf of Mexico and as far west as Texas and Minnesota. Other species include the *soft* or *silver maple*, and the *box elder* or *ash-leaved maple*.

**Sycamore** (*Acer pseudo-platanus*). This is among our noblest trees, a rival in massiveness to oak and ash. The bark is smooth, ash-grey in colour. Branches grow out low to the ground, and become vast : the higher branches are shorter, so that the whole tree may be dome-shaped. The bark and leaf-stalks of new shoots in the spring are of a clear red tint, glowing amid the bright green of the young leaves.

The five-pointed leaves (for the sycamore is of the maple family, and is often called the " great maple ") grow in opposite pairs and are six or eight inches across.

## PLANE FAMILY

(*Platanaceae*)

This family contains but one genus, that of the plane tree.

**Plane** (*Platanus*). Natives of the near and middle east, famous in classic poetry and folk lore, the planes are


HACKBERRY
LIME
POPLAR
ASPEN
ELDER
HONEYSUCKLE
CRACK WILLOW
MULBERRY
LABURNUM
ELM
Jh
PLANE
MAPLE
TREES: LEAVES AND FRUITS

perhaps the favourite trees for planting beside city streets. They are nowhere more at home than in London, and grow thickly all about the Thames Valley. The plane is especially suited to city life. The upper surfaces of the leaves are hard and polished, and so are washed clean by showers of rain ; the smooth grey bark peels off, taking all the accumulated city dirt with it. It is a tall tree, often 100 feet, sometimes 150, with long wide-spreading branches.

It has five-pointed leaves, like maple and sycamore, but they grow alternately from the stalk, not opposite. The leaves are hard in texture and make a characteristic rattle against one another in the breeze. Male and female flowers appear early in summer, in separate groups, but on the same tree, two to five flowers hanging in each bunch on a long stalk. There are little round catkins dangling on thin stalks winter and summer—chains of four to eight catkins on thread-like stalks.

The London plane (*Platanus londinensis*) is a hybrid.

## FIG FAMILY

(*Moraceae*)

This large family of about fifty-five genera containing more than eight hundred species includes mostly tropical trees, such as *upas* and *bread fruit*. Certain members of the family are grown in our land as crops, notably the *hop*, which is used in brewing beer : the hop is not a tree, but a climbing plant. The *mulberry* is often found in our gardens, and occasionally the *fig* is cultivated against walls.

## HONEYSUCKLE FAMILY

(*Caprifoliaceae*)

**Common Elder** (*Sambucus nigra*). The name of the elder-tree is probably derived from the Anglo-Saxon word *eller* or *ellarn* which means " kindler," as applied to the kindling

or blowing up of a fire. The tree probably got this name from the use to which its hollow branches were put. It is likely that these were broken off and used as blow-pipes or bellows to fan the flames, like the bamboo sticks of the tropics. These hollow branches were also used in early days as a musical wind-instrument, and many a boy to-day has made a whistle out of them, though sometimes their dignity has been degraded to serve the purposes of pop-gun or pea-shooter.

The juicy shoots of the elder contain a great quantity of pith which shrinks as the tree grows, leaving a hollow space, which can soon be cleared out by removing the pith. The stem of the elder is coated with a grey corky bark. The leaflets grow in fives, sevens or nines on the leaf-stalks (pairs of opposite leaflets with one at the tip). They have slightly toothed edges and slightly pointed tips, and a heavy scent. The creamy-white flowers grow in June in clusters, each one upon its own stalk, each cluster of stalks from one stem. The flowers are succeeded by purple-black berries which are much sought after for their sweetish half-acid juice which is made into elderberry wine.

The scarlet-fruited elder (*Sambucus racinosa*) has greenish white flowers and scarlet berries.

**Viburnum, Wayfaring-Tree** or **Guelder Rose** (*Viburnum lantana*). This large shrub or small tree is found wild in copses and hedgerows. Its young shoots are covered with a thick cottony down. Its bright-green leaves, about three inches long, are broad, and shaped into three or five *lobes*. Large clusters of white flowers appear in June and July : these flowers are arranged in rough rings, and each flower is three or four inches across. Inside each ring of white flowers is a cluster of smaller flowers, each flower less than a quarter of an inch across. These inner flowers are the only ones with stamens and pistils, the outer ones serving solely to attract insects. After pollination the flowers fade and give place to a cluster of pale berries that turn gold and then deepen through orange to red.

A beautiful species of viburnum is cultivated as a flowering shrub in many gardens, and is sometimes called the snowball-tree. All the flowers are large and white : there are no perfect and fruitful flowers ; and this garden variety has to be propagated by grafting and cutting.

**Honeysuckle** (*Lonicera periclymenum*). The leaves of the common climbing honeysuckle are among the earliest to unfold at the beginning of the year. The beautiful, delicate yellow, pink and red flowers, are among the last to fade at the end of the summer. The glorious honeysuckle, known and sought for its beauty, its sweet scent, and the abundance of its honey, is, in spite of all we may wish to the contrary, one of the venomous plants. Like a hungry cobra coiling round an animal to crush him to death, the honeysuckle climbs up towards the life-giving sun by twining round other bushes and low trees. At first green and slender, the young shoot of a honeysuckle grows with the support to which it clings, until it is hard and woody and thick. So firmly does it clinch its hold on a sapling that it stops the young tree's growth, and when a woodman has cut the tree down and torn off the honeysuckle a deep spiral furrow is seen in the tree bark where the honeysuckle has been.

Yet, apart from its beauty, scent and sweetness, and apart from its habit of growth, which makes it a danger to all young trees and shrubs, the honeysuckle is a remarkable and interesting plant. As we saw in Chapter IV it is one of those evening flowers which are specially adapted to pollination by moths which come out at twilight.

The flowers expand in the early evening and are at first white within and purplish without. The pistil is bent abruptly downward, while the anthers stand directly in front of the entrance, by which arrangement self-pollination is prevented. How graceful are the five stamens, with their bright orange-red anthers on top ! And how delicate is the little thread-like pistil which springs from the heart of the flower and bears the tiny green globe of the stigma at its tip. The five stamens and the long pistil stand well

out from the throat of the honey-tube, so that they come in the way of the hawk-moths that fertilise the flower : the honey-tube is perfectly fitted to the long proboscces of the hawk-moths, who can drink the nectar whilst hovering in front of the flower. Coming in contact with the anthers the whole underside of the hawk-moth's body will be covered with pollen, which will be shaken off on to the little green stigma of the next honeysuckle the insect will chance to visit. We have noticed in one or two instances in Chapter VI that the flower-petals offer a landing place for insects, a sort of insect aerodrome ; but since the hawk-moths take their nectar on the wing and do not land at all, the petals of honeysuckle coil right back to be out of the way, which is why the flower presents such a loose, flowing, almost straggling appearance, very different from the compact design of the ordinary bee flowers.

There are many species of honeysuckle, a few of which are not climbers, but stand upon their own stems, as all respectable plants should do, and form bushes by themselves.

Moschatel (*Adoxa moschatellina*). A curious little cousin of the honeysuckle, which has not thought fit to clamber over stronger friends and strangle them : instead, this plant spends most of its time under the ground as a knotted root, sending up, for three months in the spring, a flowering leafy shoot. Some scientists place the moschatel in a family by itself, the *Adoxaceae*.

But this chapter is really about trees ; and since this strange family of Caprifoliaceae has strayed in among the flowers, let us turn our attention to what is perhaps the most favoured and most lovely of all the flowering trees and examine the rose family (*Rosaceae*).

# CHAPTER IX

# TREES AND SHRUBS (2)

## ROSE FAMILY

(*Rosaceae*)

**Common Bramble** (*Rubus fruticosus*). Linnaeus' name for the common bramble covers more than 100 species of blackberry ; and beside the blackberries there are more than 1,000 other species of bramble which include all the strawberries, raspberries, cloudberries, dewberries and hundreds of lesser-known relatives. The family is spread over the whole world. Most of the members are fruit bushes. The loganberry is a cultivated hybrid between the raspberry and the Californian dewberry. We will take as our example of the brambles, the English blackberries. From June to September in the English hedges the white or faintly tinted blossoms of the native blackberries are to be seen. They measure about three-quarters of an inch across, and consist of a ring of five petals (corolla), which turn outwards over the supporting leaves (calyx) down towards the stem. There are many stamens and pistils within each flower. Each pistil develops into a tiny globe-shaped fruit containing one seed, and all the tiny fruits of one flower grow together into a fleshy fruit, the blackberry itself. The blackberry fruit is, therefore, many fruits rolled into one. The blackberry generally emulates the honeysuckle in climbing up to the sun by means of other shrubs or saplings which it uses as supports ; but instead of coiling like a snake, it hooks itself into the wood of the support by means of its sharp prickles. When it can find no support, it crawls along the ground,

now and then sending up a stem which will wave about in search of a support, and will sink back upon the soil if it fail to find one, thus forming a low arch which will thicken into a woody bush-like stem.

Many of the brambles grow in this way, although some, like the strawberry, never climb up, but are content to creep over the soil, sending down roots here and there, and sending up short shoots to form low prickly bushy growths less than a yard high.

Bramble leaves are generally a little spray of three or five leaflets growing from the tip of a stalk. The leaves are rough and hairy, deeply veined and roughly toothed. In raspberry and a few other species of bramble, the leaves are whitish on the under-side.

Strawberries and raspberries are, as everyone knows, cultivated throughout the old and the new world, though in North America the blackberry also is cultivated in many parts.

One of the delights of a country ramble is to engage in a search for wild fruits. I can never forget the first time I came across a wild strawberry plant in Oxfordshire when I was a boy. The fruit was ripe, and had a high, exciting taste, less sweet, but to me far more delightful, than the taste of the bigger cultivated varieties in the gardens. I could not have been more excited if I had captured a wild elephant.

The common wild strawberry (*Fragaria vesca*) is almost exactly like the garden plant, excepting that the fruit is smaller, no bigger than a raspberry. As a rule the plant sends up several flowering stems about four or five inches high, which are round and unbranched, and bear one or two leaves. They are always clothed with outspreading hairs. The chief leaves spring up from the root, and are composed of three roundish-oval leaflets with coarsely toothed edges. The flowers appear in May and June, and measure about half an inch across. The five petals are white, and have a large green calyx beneath them.

You can, of course, come across wild raspberries and

other edible bramble fruits. The European wild raspberry (*Rubus idaeus*) has red fruits. One of the interesting relatives of the common raspberry is the cloudberry, or knotberry, sometimes called the mountain raspberry (*Rubus chamaemorus*) which finds its home among the clouds on mountain-sides. It is found in the mountains of Scotland and Wales, and in the higher parts of the north of England.

All these species of bramble belong to the marvellous family of the rose, Latin name *Rosaceae* ; but whereas the flowers of most members of this family are " perfect " the cloudberry is an exception, one plant bearing male flowers (stamens only), another plant female (pistils only).

Of the more than 1,000 species of bramble in the north temperate zone we have no room to speak in this book ; but we should now be familiar with the general features of the group : you may find a score and more species in a day's walk across country. We must now pass on to the larger flowering trees which come within the rose family.

The house of a friend of mine looks out upon one of the most enchanting groups of trees in London. There are half a dozen tall, great-girthed chestnuts, two of the pink-blossoming variety, the rest with white flowers. Between them in May time they make a mountain-mass of blossom, a swelling sea of green and white and pink.

Below the mountainous chestnuts, standing a short distance away, is a row of hawthorns, or may-trees. Now, the peculiarity of the hawthorn seems to be that no two hawthorns are ever alike. That row of may-trees shows as many shades of pink as can be found in the best Bond Street dress shop ; and the shades are finer, grading off from tree to tree, so close-pressed are the trees, so intense the mass of their bloom. You can never see the trees for the flowers when May is half way through.

**Hawthorn or May-Tree** (*Crataegus oxyacantha*). A small, round-topped, much-branched tree is the may-tree, ten to twenty feet high, the branches often ending in single sharp spines. The leaves are deeply cut, one to two inches long,

and very variable in shape. The flowers are sweet-scented, in flat-topped clusters. Each flower one quarter of an inch across, with five spreading petals, a large number of stamens with pinkish brown anthers. The flowers develop into little fruits bearing in the heart of them one to five stones. There are varieties of hawthorn with white, pink and red flowers, with single flowers and double flowers, with yellow, with orange and with red fruit. There is a near relative, known in gardens as pyracantha, which has white flowers, and scarlet fruits the size of a pea. This is often planted against the walls of houses, where it glows throughout the winter, until the birds strip it of its fruit.

**Blackthorn** or **Sloe** (*Prunus spinosa*). The blackthorn is one of the commonest wayside flowering shrubs in Britain. The delicate white blossoms appear in March or April before any of its leaf-buds have begun to open. The flowers are about the size of a may blossom, which blackthorn resembles in many ways. They open very widely and have long spreading stamens which give them a whiskered appearance. The flowers grow singly or in pairs, not only on the twigs, but also on the long spines in which many of the smaller branches end. The blackthorn never develops into so large a tree as the hawthorn, but remains a gnarled and twisted bush with deep black branches. Yet how beautifully it clothes hedges and decks out small woods in early spring with masses of snowy flowers ! The flowers give place to small dull-green fruits, which turn a bluish purple colour in August or September. They resemble very tiny blue-black plums, not much bigger than peas, and very bitter and harsh to the taste. Too bitter to eat raw, they are bottled and made into " sloe gin," sloe being the popular name for this little fruit. The leaves of the blackthorn are dark green, and oval in shape with finely toothed edges.

**Bullace** (*Prunus institia*). Is a very near relative of the blackthorn, which it resembles in many ways. The bullace, however, has brown branches, and often grows into a small

tree. It has straighter and less spiny branches, and larger and less clustered flowers.

Blackthorn and bullace belong inside the rose family to a group called *Prunus*, as their Latin names reveal. In this group belong the plums, peaches, cherries and almonds.

**Plum.** Some botanists consider the plum, the damson, the sloe and the bullace to be forms of the wild plum (*Prunus communis*). The wild plum is a shrub or a small tree similar to the bullace in the shape of its leaves and the colour of its bark. The branches do not possess spines. The fruits are oval or oblong, about one to one and a half inches in length, and black. The leaves are small and egg-shaped with toothed edges. The flowers grow in small bunches, each with five petals, numerous stamens and one pistil. The cultivated plums have arisen from this wild plum and also from the wild species called *Prunus domestica* which is very similar.

The *greengage* is a variety of plum first grown in France by a man named Gage. The *damson* is a very early variety, and gets its name from the city of Damascus, where the fruit was grown before the Christian era under the name of " damascenes."

**Apricot** (*Prunus armeniaca*). The apricot is a small tree native to Mongolia and Turkestan. The branches are smooth and the flowers appear before the leaves. The fruit is yellow, round or oval, and has a hairy, velvety skin.

**Peach** (*Prunus persica*). The peach is said to be a native of China, where it was certainly cultivated as early as 2000 B.C. The peach is a medium-sized tree with long lance-shaped leaves, finely toothed, borne on long, slender twigs. The flowers grow singly or in little bunches on the younger branches. They have a hollow tube at the base from which spring five sepals, five spoon-shaped petals, pink or white, and a great number of stamens. There is but a

single pistil in the centre. The fruit is of much the same size and shape as the plum, and is of a yellowish or pink flesh-colour, the skin being covered with fine velvety hairs.

The *nectarine* is a variety of the peach. The skin of the fruit is smooth, and the fruit itself is smaller. The nectarine is of a richer colour and has a more luscious flavour than the peach ; but so closely related are they that sometimes one branch of a peach-tree will bear smooth-skinned fruits (nectarines) and another branch will bear downy fruits (peaches). If you sow the stones of ripe peaches they will sometimes produce seedling nectarine-trees, while stones from ripe nectarines may yield peach-trees.

**Cherry.** The parents of all the cherry-trees are a few closely related forms of wild cherry, such as the gean (*Prunus avium*) and the common cherry (*Prunus avium*). The gean, or wild cherry, is a small tree growing from twenty to thirty feet high, with short stiff branches that tend to stick upwards. The leaves are pale green, somewhat hairy beneath, borne on long stalks, which tend to hang down. The fruit is heart-shaped, black or red, bitter to the taste, and is smaller than in the cultivated varieties of cherry.

**Almond** (*Prunus amygdalus*). The almond-tree grows from twenty to thirty feet high, and closely resembles the peach in general appearance and bloom. Almonds are of two kinds, bitter and sweet. The sweet or edible almond is cultivated commercially in the southern half of Europe and in California, and it ripens its fruit in the south of England and in many gardens throughout the States. The fruit is a hard nut which contains a valuable oil.

**Apple** (*Pyrus malus*). With the apple we come to the second group of fruit trees within the family Rosaceae. The *Prunus* group are stone fruits. The apple belongs to the

*Pomoideae* group, in which the fruits contain several small seeds. The Pomoideae is by far the most important botanical group of fruit-trees, and of them all the apple is the most valuable. The common apple, *Pyrus malus*, has been in cultivation since prehistoric times. Charred remains of the fruit have been found in the mud of the lakes inhabited by the Lake Dwellers. The apple was in cultivation in England long before the Roman Conquest. The name of the ancient British town of Avalon, connected with the legends of King Arthur and the Knights of the Round Table, comes from the word for " apple orchard." Avalon existed on the site of Glastonbury. Cider, the well-known drink made from apples, is reputed to have been first introduced into Britain by the Phoenicians who traded in tin with the Cornish folk in Old Testament times. The orchards of Devon, Somerset, Gloucester, Hereford and Worcester may date from the days of the Phoenician traders.

To-day the apple is the most important fruit of temperate regions and is grown throughout Europe, North America and largely in Asia, in North and South Africa, in Australia, New Zealand and the Near and Middle East. Each section of the world possesses a certain number of varieties which are peculiarly suited to its soil and climate. North America is the most productive apple-growing area in the world.

*Pyrus malus*, sometimes known as the crab-apple, is the wild ancestor of all the cultivated varieties of apple-trees. It is a small tree ten to thirty feet in height, with a trunk and branches of grey-brown bark, the branches close-set and very crooked. The leaves are oblong or oval in shape with a pointed tip and toothed edges. Sometimes they are almost round. They are glossy and dark green. In April or May when the crab-trees are in blossom in the woods they present an exquisite sight. The flowers grow in thick clusters and attract crowds of bees. They are pale pink and white in colour, with thick yellow stamens. All the stalks of a cluster of flowers spring from the same point at the tip of the stem, and below where they spring from is a rosette of leaves making a dark-green background for the flowers. The

fruit is small, about an inch across, and is yellow or red in colour. It has a very acid taste.

**Pear** (*Pyrus communis*). The pear is very closely allied to the apple, and the wild pear-tree's main distinction from the crab-apple seems to be that the pear is neater in appearance and may grow to a greater height. It has less closely-growing branches, and these spread out more and droop gracefully down. The leaves are scattered along the branches and are generally on a larger and more slender stalk than are those of the apple ; otherwise, they very closely resemble those of the apple in shape and colour, though they tend to be a little smaller than crab-apple leaves. Both crab-apples and wild pears are used as " stocks " on which to graft cultivated varieties in the manner we noted when dealing with the purple beech. Pears are cultivated almost as extensively as apples, and varieties occur in every locality. The flowers appear in May, and are very like those of the crab-apple, but are pure white instead of pink tinted. The fruits are like miniature garden pears, but are too bitter to eat.

**Quince** (*Pyrus vulgaris*). The quince, " the golden apple of the Hesperides," is the closest relative of the pear. It is a low and slow-growing tree, bearing white or pink flowers in June, followed by apple-shaped or pear-shaped fruits of a rich golden hue. The quince is cultivated less to-day than it was twenty-five years and more ago.

**Medlar** (*Pyrus germanica*). The medlar is a small tree with spiny branches and large white flowers growing on the ends of the spines. The fruit is roundish pear-shaped, and is curious in that the flower sepals cling to it and bear it as in a cup of leaves. Like the quince and many other fruits, it is less cultivated now than it was. Abraham Cowley,[1] the

[1] Abraham Cowley, 1618–1667.

English poet who lived in the time of King Charles I and Cromwell, wrote of the medlar and of the practice of grafting :

> " *Man does the savage hawthorn teach*
> *To bear the Medlar and the Pear :*
> *He bids the rustic Plum to rear*
> *A noble trunk and be a Peach.*"

The medlar was known to the ancients. Theophrastus, who wrote in 300 B.C., mentions the fruit as being known to the Greeks.

**Mountain Ash** or **Rowan Tree** (*Pyrus aucuparia*). The mountain ash attains a height of from ten to thirty feet. The buds are large, violet-black or grey, covered with velvety white hairs. The leaves consist of strings of little leaflets, growing opposite each other from the stalk, twelve to sixteen of them, with one growing from the tip of the stalk. (This arrangement of leaflets, which we have noted in several other species of tree, is called *pinnate*). The leaflets are at first downy on their under-sides, but the down disappears as the season advances, though, like most leaves, they remain paler below than above. The flowers are small, only one third of an inch across, but scores of them are clustered into big sprays at the tips of the branches. They are white, and their place in time is taken by dense clusters of berries, at first green, scarlet when ripe ; though it is a curious scarlet, with a glint of gold or orange in it. The fruit is very bitter, though is not unwholesome.

**Wild Service** (*Pyrus torminalis*). The wild service has leaves like those of the mountain ash : the tree, however, may grow to a greater height. The flowers are pure white and grow in clusters at the end of short leafly branches. They are larger than those of the mountain ash. The fruits are greenish brown with paler dots. They are the size of haws and may be eaten. White beam (*Pyrus aria*) is a tree

closely related to the wild service. The true service (*Pyrus sorbus*) also closely resembles the mountain ash in shape, leaves and flowers. The fruits, which may be apple-shaped or pear-shaped, are greenish brown, with rusty specks, and are four times the size of wild service berries.

**Spiraea.** The willow-leaved spiraea (*Spiraea salicifolia*) is a shrub of four or five feet, with rather slender branches, oblong toothed leaves, pink flowers growing in dense pyramids. There are many cultivated varieties. Members of this genus which are not shrubs or trees, but herbs, include the wildflowers meadowsweet (*Spiraea ulmaria*), wood avens (*Geum urbanum*), agrimony (*Agrimonia eupatoria*), burnet (*Poterium officinale*), dropwort (*Spiraea filipendula*).

**Lady's Mantle** (*Alchemilla vulgaris*). A green blossoming perennial wildflower of the woods and meadows.

And last, but not least, in the family of the rose, we come to the rose itself.

Roses were cultivated in the early civilisations, probably long before Nebuchadnezzar built his hanging gardens in Babylon. No one knows the origin of the white rose of England. There is a tradition, dating from time immemorial, that England was called Albion (from Latin *albus*, " white ") from the beauty of her white roses.[1] The red rose of the House of Lancaster was possibly a variety of the white rose of the House of York.

There are three main classes of cultivated roses to-day. (1) Bush roses ; (2) Climbers ; (3) Ramblers. The earliest bush roses were produced from three species, the " French," the " Cabbage " and the " Damask." The French rose (*Rosa gallica*) is a native of Europe. It bears its flowers on stiff, upright stalks, one flower to one stalk. The flowers are usually red. The cabbage rose (*Rosa centifolia*) is probably a native of the Near East. It bears clusters of very sweet-scented white or pinkish flowers, usually double : that is,

[1] Pliny wrote : " The Isle of Albion is so called from its white cliffs washed by the sea, or from the white roses with which it abounds."

usually having two rows of petals. The flower-stalks of the cabbage rose bend gracefully. The damask rose (*Rosa damascena*) also comes from the Near East. It bears single or double flowers, red or white, in great clusters, and its stems are armed with bristles as well as the usual thorns. The famous " attar of roses " is distilled from the damask rose.

Of climbers, the musk rose (*Rosa moschata*), was the first to be introduced to Europe, and is the parent of many garden varieties. It is a native of the east. It sends up very long woody stems, or canes, which are armed with stout thorns. The flowers are yellow or white, and are borne in large wide clusters.

The rambler rose (*Rosa multiflora*) sends up long arching canes which can be trained over pergolas or round pillars. It bears fine masses of crimson or pink blossoms.

From these few groups of rose, and especially from the tea rose (*Rosa indica odorata*), have come the many hundreds of cultivated varieties which gardeners have produced by cutting, grafting, artificial cross-pollination, and all the means at their disposal. Thus man has moulded the rose nearer to his heart's desire; yet many of the wild roses of the country-side have a beauty no man can enhance.

The dog-rose (*Rosa canina*) hangs a garland of blossom on the English hedgerows and throws trailers of bloom around many a copse. The flowers of the dog-rose, which grow in clusters of three or four, vary in depth of colour, being sometimes almost white, but usually various delicate shades of pink. The five broad-spreading heart-shaped petals, so quick to fall, bear in their centre a little ring of golden-headed stamens round a cluster of green-topped pistils. Later, these develop into the brilliant scarlet and orange hips that light up the dark winter days with their flashing colour, and are so beloved by the birds.

The name " dog-rose " was given by the Greeks on account of their belief that the roots of wild roses would cure the bite of a mad dog. The Romans accepted this groundless belief, and the name has come down to us.

Besides the dog-rose there are many varieties of wild rose, such as the field-rose (*Rosa arvensis*), the blooms of which are scentless, the burnet or Scotch rose (*Poterium officinale*), a small bush which bears a forest of short branches well armoured with thorns : the thorns of the burnet are straight, those of the dog- and field-roses being hooked. The sweet-briar or eglantine (*Rosa rubiginosa*) has as a rule more slender stems and stalks than those of the dog-rose, and these are more thickly crowded with bristly prickles : the leaves are small and if you bruise them they yield a sweet smell. The flowers are rather smaller than those of the dog-rose.

The above are, of course, but a few of the hundreds of species and varieties of wild roses ; and we have room to say only a few words about the general form of all roses. In the natural state, and in the single garden varieties, roses have five broad or roundish petals within a calyx of five sepals. The roses are "perfect" flowers, tending to have numerous stamens and pistils ; and here is a curious thing we may note, though it is a feature which roses share with several other kinds of flowers. No rose has any nectar.

It seems odd that such a sweet-smelling flower secretes no nectar. It seems even more strange that although the blossoms of so many other species in the family have nectar the rose produces none. The blossoms of apple, pear, plum, cherry, raspberry and several score of other members of Rosaceae bear abundant nectar ; but the rose is nectarless. It does not always follow that because some members of a flower family bear nectar, all the other members must do so. In the family called Caprifoliaceae, at which we looked in the last chapter, the honeysuckle and the viburnum have plenty of nectar, but the elder produces none. Some orchids secrete nectar, others do not. In the Solanaceae—a family we are just about to examine—the nightshade group has no nectar, but the ground cherry has plenty. And so it goes on.

Does this mean that roses are either wind-pollinated or self-pollinated ? Of course not ! Those glorious petals, with their range of hue from crimson to white, are there to

attract insects for cross-pollination, a task in which the fragrant scents are also aiding. And since honey bees, bumble bees, leaf-cutting bees, mason bees, ground bees, flies and beetles, visit roses regularly, there must be some other attraction than nectar. That other attraction is pollen.

Insect flowers that have no nectar are called pollen flowers ; and it is safe to say that an insect visiting a rose, in order to gather or to eat pollen, can never fail to get some pollen on his back from those numerous stamens ; and some of that pollen is bound to find its way into the stigmas on the pistil of another rose.

The leaves of rose are usually longish oval, toothed round the edge, growing in sprays of leaflets, about five leaflets to a spray.

## NIGHTSHADE FAMILY

(*Solanaceae*)

This family contains plants so different as the potato and the deadly nightshade, the tomato and the horse nettle, the tobacco plant and the plant of cayenne pepper. There are, altogether, about 72 genera and 1,750 species of plants in the nightshade family.

**Tobacco** (*Nicotiana tabacum*). This plant is by far the most important of the Solanaceae. A native of South and Central America, it is now cultivated throughout the world. In the western hemisphere it is grown in scattered plantations from Quebec to Chili, in the eastern hemisphere it ranges from Sweden to South Australia. It is grown here and there in the south of England, but the United States produces about 35 per cent of the world's crop, chiefly in Kentucky, Virginia, North and South Carolina, Tennessee, and Maryland. As with fruits, the quality of tobacco and the type of tobacco plant vary with the soil and climate.

**Potato** (*Solanum tuberosum*). The habit of the potato plant in storing its winter food in its roots has made it of

value as food for man. The potato plant's roots develop a great many branches under the soil and certain of these swell up at the ends into what we call *tubers*. From the plant's point of view a tuber is a store of food for the winter. From man's point of view a tuber is the potato for his meals. The potato plant, like tobacco, is a native of Central and South America, but since its introduction to the old world Germany and France have become the greatest of all potato-producing countries. In some parts—in rural Ireland, for instance—the potato has become the chief food of the peasants.

The potato is a perennial plant with smooth herbaceous stems from one to three feet high, with pinnate leaves, and white or purple flowers about one inch wide, producing a globe-shaped, purple fruit or *seed-ball*, of the size of a gooseberry.

The tubers are on underground branches which are not real roots. Certain tubers have what are called " eyes." The " eye " is usually a group of buds which lie in a little dent in the tuber. The " eye " is a miniature bud, which is able to produce a new potato plant.

Tomato (*Lycopersicum esculentum*). An old gentleman, with whom I used to stay at the seaside, would never eat tomatoes " because," he said, " they are new-fangled things." He liked the old-time onions, and such respectably historical vegetables as the lettuce. That old gentleman was in quite the majority at one time ; for, in the beginning the tomato was considered to be poisonous and was eaten by nobody except the native Indians of South America, from whence it came. There can be few people to-day who have not been to a house where tomato plants are ripening in the conservatory, or even on a window shelf on the sunny side of the house. Nowadays the tomato is cultivated in all temperate regions, and is considered to be one of the most wholesome and important garden vegetables. The red sorts, with smooth round fruits, a little flattened at the ends, and varying from two to four inches in diameter, are most

in cultivation, though there are more than 150 cultivated "varieties."

Maybe the innocent and wholesome tomato was suspected of being poisonous because it is a relative of many poison weeds such as the deadly nightshade (*Atropa belladonna*). The deadly nightshade has dingy purple bell-shaped flowers, which give place to large, black, shining berries. Every part of this plant is poisonous, but especially the juice of the berries.

Another weed belonging to Solanaceae is the henbane (*Hyoscyamus*) a plant covered with hairs from which issue a sticky juice that has an unpleasant smell. The flowers are a murky yellow with a network of purple veins on the petals. The large, coarse, hairy and deeply veined leaves grow from the stem with no stalk of their own. A long pistil bears its stigma over the heads of the five purple anthers. The plant is adapted for cross-pollination by bumble-bees, but a curious point about it is that if the flower is not cross-pollinated by bumble-bees the petals lengthen and bring the anthers to the stigma, which effects self-pollination.

The solanaceae family also includes the following :

**Bittersweet** (*Solanum dulcamara*). Sometimes called woody nightshade, the bittersweet is a perennial that trails and climbs over hedges and bushes and sometimes reaches a length of twelve to fourteen feet. The corolla, deeply cut into five petals, is purple in colour, and from it protrude five yellow anthers which unite to form a cone. The ripe fruit is a scarlet egg-shaped poison berry. The bittersweet flower contains no nectar and is mostly self-pollinated.

**Jimson Weed** (*Datura stramonium*). Sometimes called thorn-apple on account of its spiny fruits, the common jimson weed is one of the few plants of solanaceae which is cultivated as a garden flower. There are many species, some as wayside weeds.

**Mandrake** (*Mandragora officinarum*). Mandragora, the classical botanic name for the genus of this plant, was used by Hippocrates, and is said to mean that the plant is hurtful to cattle. It is a perennial herb about which a good deal of superstition has centred in days gone by. The large spindle-shaped root is supposed sometimes to become forked and resemble the human form. The notion that the plant shrieked when touched is alluded to by Shakespeare in *Romeo and Juliet*. " And shrieks like mandrakes torn out of the earth, that living mortals, hearing them, run mad." The leaves are large, stalked with wavy margins. The flowers purple, bell-shaped and upward pointing : they may be almost white, pale violet or blue. The fruit is an oblong or globe-shaped juicy berry. There are three or four species of mandrake.

**Petunia.** This is by nature a perennial plant, but is much cultivated in hot-houses and gardens as an annual. There are a very great number of cultivated varieties, some with single, some with double flowers, ranging in colour from white, rose, pink and violet to deepest purple. All these garden flowers have been derived from two main wild forms, *Petunia nyctaginiflora*, with trailing white flowers, and *Petunia violaceae*, with trailing purple-violet flowers. Each flower grows on a separate stem, and has a calyx deeply five-parted, with a corolla in the form of a funnel, long and straight, springing out of the calyx. Five stamens and one pistil inside. The leaves are oblong and straight edged, and are usually rather sticky, and give out a peculiar smell, especially in the evening, or during stormy weather. At nightfall sphinx-moths visit the flowers and cross pollinate them.

## LAUREL FAMILY

(*Lauraceae*)

**Laurel** (*Laurus nobilis*). This is the ancient laurel of old-world history, the laurel of victory and peace.

*Laurus nobilis* is a large evergreen shrub, sometimes

growing as high as sixty feet. The leaves are long, and broadly lance-shaped, of a leathery texture, stiff and stout, with toothed margins. It bears yellowish flowers in the early spring, with purple cherry-like fruits following in the summer.

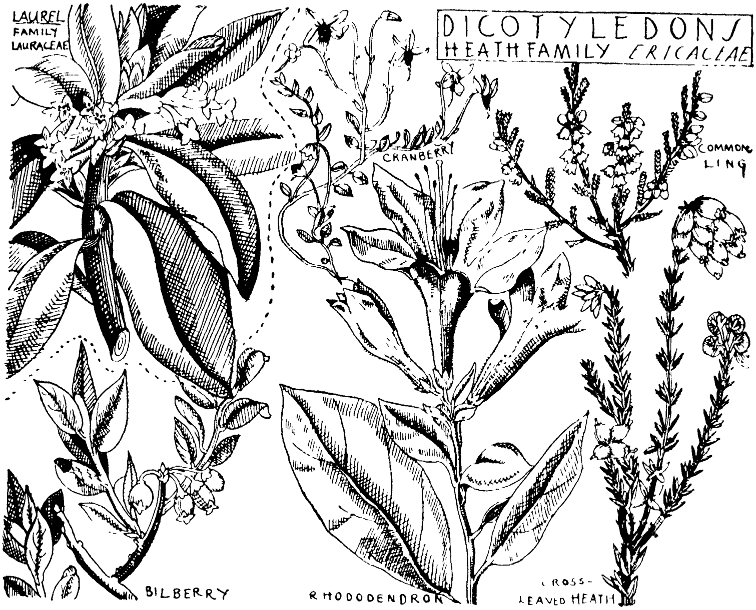
This laurel is interwoven with human history almost as much as is the oak tree and the mistletoe. It was a sacred bush in the ancient world, dedicated by the Greeks to Apollo. It became the symbol of triumph in Rome as well as in Greece, and, like the olive branch, served as a sign of truce. It was believed that lightning could not strike the laurel, and the emperor Tiberius always wore a laurel wreath during thunderstorms. It is the " green bay tree " of the Bible, and to-day it is sometimes referred to as the sweet bay. The laurel is an evergreen.

## HEATH FAMILY

(*Ericaceae*)

**Rhododendron** and **Azalea.** Rhododendrons and azaleas are so closely related and so similar in structure that they would be classed as one genus of flowering shrubs but for two facts. Rhododendrons are nearly all evergreen and their flowers usually have more than five stamens. Azaleas are nearly all deciduous and most of them have in their flowers five stamens, no more. There are, however, more than 700 different kinds of rhododendron and azalea, and some few of these vary so much as to create uncertainty as to which they are.

These bushes are, of course, cultivated for their flowers, which are large, and borne in wide-spread clusters, so that often the result is the appearance of a bush of brilliant flowers, often of the most glorious tints. The flower-buds come forth in the winter out of the wood, and remain protected by gummy leaves until the warm spring weather, when they open out revealing a trumpet-shaped corolla (in some species it is bell shaped) with five petal-lobes.




Sometimes the flowers have hardly any calyx, or, indeed, none at all.

*Rhododendron maximum* is known as the great rhododendron, the great laurel, or the rose bay.

The azaleas are mostly American ; but *Azalea pontica*, a shrub three to five feet high, is a native of the countries round the Black Sea, with large, oblong, lance-shaped, shining leaves and flowers covered with sticky hairs that give out a very sweet smell. It is common in gardens and shrubberies in Great Britain and America, and varies with orange, yellow, red and almost white flowers. The whole plant is narcotic and poisonous, as are many species of these lovely flowering bushes of the heath family.

**Heath, Ling** or **Heather** (*Calluna vulgaris*). Who has seen the hills of Scotland, the moors of Yorkshire, or the rolling stretches of Dartmoor, glowing with purple heather, like some land of ember-fire, needs not to read the praise of

heather. These low-growing evergreen shrubs entwine themselves together and form a living mat over hills and dales where nothing else can grow, and in July and August they unveil their strange rose-lilac colour, that runs across the moors like prairie fire. The stems of heather are covered with a smooth downy brown bark, and the numerous short green twigs bear four rows of small narrow leaves which are keeled at the back and channelled in front like tiny boats, with their margins delicately fringed. On the uppermost twigs the pink-purple flowers swell up and burst forth in showers of colour. The flowers have four sepals which are coloured like the corolla, and outside and below them the leaves seem to form a further calyx or ring of green sepals. Inside the true calyx of coloured sepals rises a bell-shaped corolla deeply cleft into four parts. Inside the corolla a long pistil holds half its length above the eight stamens which form a close ring around the pistil. The anthers are dark red, and each has two white tails which stand out to the walls of the corolla. Honey bees are very fond of the heather, for the nectar at the bottom of the corolla can be got at easily, and the close clustering of the flowers saves the bee many journeys. The tall pistil comes in the way of the bee as the insect lands, and pollen brought from another flower gets brushed off on to the stigma. In getting down to the nectar, the bee's head has to press against some of the anther tails, and this shakes the stamens and there falls out upon the bee a supply of pollen for transportation to another flower.

There are about 500 known species of heather of which *Calluna vulgaris*, which we have described above, and *Erica cinerea*, the purple or five-leaved heath, are perhaps the most common and beautiful. The flowers of both these species yield much honey.

**Wintergreen** (*Gaultheria procumbens*). A small creeping evergreen shrub. The broadish-round leaves are stiff, thick and shiny dark green, with a few small teeth set wide apart on the edge of the leaves, which grow on very short stalks,

and sometimes have none at all, springing straight from the buff, brown or ruddy stem. The waxy flowers are vase-shaped and hang down from the axils of the leaves. The berry is a deep red colour, and is formed by the calyx which becomes fleshy and grows round the ovary. Other names for wintergreen are tea-berry, checkerberry, boxberry, spice-berry and ground holly.

**Arbutus.** There are about ten species of arbutus native to Europe and North America. They are shrubs and trees. In many species the leaves are evergreen and shining. The branches are usually smooth and red.

*Arbutus unedo* or strawberry-tree, is a small evergreen tree native to the south of Ireland, cultivated occasionally in gardens in England. It has a short, sealy-barked trunk with many branches, and attains a height of ten or twelve feet only. The long, pointed, oval leaves are stiff and smooth and have toothed edges. The small bell-shaped flowers are produced abundantly in drooping sprays from August to October, and are cream-coloured. The fruit take a year to ripen and are fully ripe when next year's flowers are out, so that fruit and flowers appear together on the same tree. The fruit resembles a strawberry in size and colour, and is good to eat.

The trailing arbutus (*Epigaea repens*) is the mayflower of New England.

**Bilberry.** The bilberry, *Vaccinium myrtillis*, is a low-growing shrub found in copses, woods, and on heaths. Oval leaves with toothed margins, small, roundish, rose-green flowers, and dark-blue waxy berries. The British species are called bilberries, blaeberries or whortleberries.

**Cranberry** (*Vaccinium oxycoccus*). This creeping evergreen shrub is closely related to the blueberry. The English species have thread-like, minutely downy stems that lie along the ground, rooting at intervals, a manner of growth we observed in the strawberry. The scattered oval leaves

are only a third of an inch long, and tend to curl up. They have short stalks, are deep-green above, shining and sticky below. The rosy flowers, found from June to August, only a third of an inch across, are wheel-shaped, the four petals turned back, exposing the purple stamens with yellow anthers. These are followed by dark-red round berries.

The cowberry or red whortleberry is closely related to the bilberry and the cranberry. It is a dwarf evergreen shrub found in woods and on heaths chiefly in mountain districts. It has twisty wiry stems and branches that trail on the ground. Oval leaves an inch long, green and glossy on the upper side, pale and dotted underneath, their sides thickened and rolled back. Drooping pink bell-shaped flowers forming little sprays at the ends of the branches. The berries are of the same size as those of the bilberry, but are red and acid.

## BOX FAMILY

(*Buxaceae*)

**Box** (*Buxus sempervirens*). A small tree native to Britain and Europe, where it forms woods, and even, in some places, forests. The young branches, which have usually an upward direction, are downy and have a smooth yellowish bark. The older trunks and branches are rough and grey. The leaves have very short stalks, edged with two lines of minute hairs, and are generally less than an inch in length, oblong, leathery and with a peculiar smell. Tiny pale whitish-green flowers appear in April and May forming crowded spikelets. The flowers have either anthers or stamens, never both.

## WALNUT FAMILY

(*Juglandaceae*)

**Walnut** (*Juglans regia*). Walnuts are usually large quick growing trees. The trunk, at a short height, gives off large up-tending boughs which have much-twisted branches that create a splendid labyrinth, and in summer a deep and

beautiful mass of foliage. The leaves are pinnate, usually from five to nine : that is to say, we remember, there are from five to nine leaflets which grow in pairs from the leaf-stalk with one growing from the end. The end leaflet is generally rather larger than the others. They all have a smooth oval outline and tend to be rather pointed at the tip. The surface of the leaves, like their edges, is smooth, and their colour is perhaps a brighter green almost than any other tree : there is a touch of red and a pale yellow tint in the dark-green oval leaflets that gives them a strong bright hue that makes a walnut tree conspicuous against the foliage of the ordinary run of trees. These leaves give out a strong but not unpleasant odour when bruised. Male flowers are borne on drooping green cylinder-shaped catkins, the female flowers grow singly or in tiny bunches at the end of the youngest shoots. The nut is a true fruit and has a double coat—a green fleshy cover with the hard nut within. Inside the hard nut is the kernel, which is the seed.

## HOLLY FAMILY

(*Aquifoliaceae*)

**Holly** (*Ilex aquifolium*). The name " holly " is said to be derived from the use of the branches and berries to decorate churches at Christmas, from which the tree was called holy tree. The bark of holly is smooth, and light grey, as is often clung to by a species of lichen. Branches may spring almost from ground level. The Latin name, *aquifolium*, " sharp leaved," does not describe all the leaves, since it is only the lower leaves on a holly bush that have sharp prickles round the edges ; the higher ones having smooth edges. The small, whitish flowers appear in May, June or July, in clusters in the axils of the leaves. The red fruit, which is a stone fruit, like the plum, ripens in September or October. The leaves of holly are poisonous. It is a native of Europe and western Asia.

The mistletoe which so often accompanies holly as a

Christmas decoration belongs to another family, called Loranthaceae.

But we must close our brief view of the trees with but a word about two more families.

## MAGNOLIA FAMILY

(*Magnoliaceae*)

**Magnolia.** The largest tree-flowers known belong to the magnolia. One southern species *Magnolia macrophylla* has a white flower, with a purple centre, which measures ten inches across. In the south, several species of magnolia reach the height of trees, *Magnolia grandiflora* or bull bay rising from 60 to 80 feet. When, in the southern spring days, groves of this great magnolia dawn upon the earth and fill the air with their intoxicating scent, they seem, as one writer has said, " not to belong to this world, but to some big, splendid planet such as Saturn." The magnolias are southern plants—natives of the southern States of North America and of south-eastern Asia. They are only seen in their true splendour and beauty in the south. In our colder northern climate some magnolias grow no bigger than shrubs ; but even so they are cultivated in many gardens in our clime.

The small magnolia or sweet bay (*Magnolia virginiana*) is frequently found as a shrub in the north (it grows to tree size in the south). Its bark is light brown-grey. The new twigs are green and turn a ruddy hue as they grow older. The leaves are thick, oval-shaped, and at most not over six inches long, whitish underneath and borne on a slender stem. In the south this magnolia is evergreen, but the leaves fall about November in the north. The cream-white flowers are roundish and fragrant and bloom from May to August.

## TAMARISK FAMILY

(*Tamaricaceae*)

The curious desert-loving tamarisk is the last plant with which we have room to deal among the trees and shrubs.

It is familiar to many as growing thickly upon sand-dunes beside the sea—long, thick hedges of wiry shrubs that whistle and rustle in the wind. The leaves of tamarisk resemble the needle-leaves of firs, though in many species of tamarisk the leaves cling like scales to the stem and branches. The leaves are small so that they shall present a small surface to the sun and shall not transpire at all freely. They do not wish the precious root-water to evaporate through their stomata, because they live, like desert Arabs, in places where water is precious indeed. The flowers of tamarisk are very minute, borne in chains, and are wind-pollinated.

# CHAPTER X

# FROM BUTTERCUPS TO DAISIES

SAYING "*from buttercups to daisies*" is like saying "*from log cabin to White House.*" Nearly the whole history of dicotyledon flowers lies between the buttercup and the daisy, which are almost as different as any two flowers can be, though they grow side by side on so many green grass banks and sunny meadows.

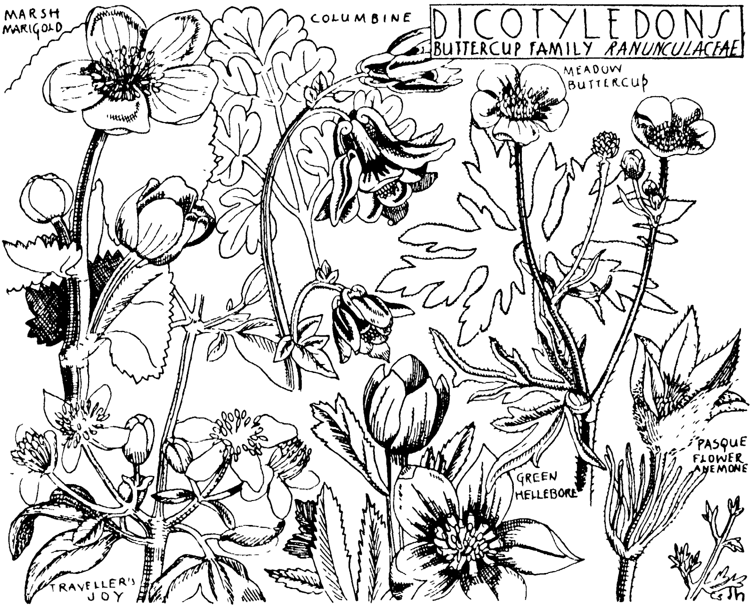
There are about 250 dicotyledon families between the "log cabin" buttercup and the "White House" daisy; and included in this wonderful array of flower families are all those stately tree families at which we have been looking, and many other tree families which we have had perforce to omit from our view of the world of nature. And of course we cannot now begin to visit the 200 and more flower families that remain—it takes botanists a dozen volumes to give the briefest descriptions of the type-flowers only.

The best thing we can do is to look at the buttercup family and the daisy family side by side, and judge of the history of flower life which lies between them.

## BUTTERCUP FAMILY

(*Ranunculaceae*)

I remember once in Switzerland walking up into the snowfields above Wengen in the spring. I had admired the armies of white crocus and pale soldanella spread out on the grass beside the drifts of snow. I had been wishing that they had some colour, for these are pale ghost-coloured flowers. I came to the head of a steep bank and stood looking out




across the mighty range of the Jungfrau ; and I decided to walk down the long grass slope into the depths of the ravine. No sooner had I clambered over the edge of the bank than a dazzling spectacle met my gaze. It was like a seam of pure and solid gold cropping out on the green hillside—a hundred-foot-deep colony of marsh marigolds, nodding their heads in the swift currents of a score of streamlets.

The marsh marigold is a flower of wide range, being found among mountains, up to 3,000 feet, and also down by the sea. It is often the flower which enlivens the mountain streams of Scotland in the early year, and is very common in France, where it is called *souci d'eau*, " the guardian of the waters." In Scandinavia whole plains are yellow with it, and its opening is eagerly looked for by the northern villagers, as it is the first flower which blooms wild in their countryside when the green grass appears from under the vanishing snow. Few flowers are more abundant

on the marshy lands of Holland. It is common in Italy, and in wet meadows in the United States from Maine to South Carolina and out to the west. It is on sale in the streets of Boston in spring, and is found in glowing multitudes in the English meadows and among the hills of Wales. I have seen great sweeps of it paving the " bled " of Morocco with gold.

It is a thick and stocky plant with a hollow stem, with roundish, deep-green leaves and brilliant golden-yellow flowers. The flowers are cup-shaped, and are curious in having *no petals*. The outer leaves or sepals that enclose the flowers open out and become coloured like petals. There are only two or three flowers to each stem, and each flower grows solitary from a stalk branching off from the stem. One flower blossoms before another, so that there is a succession of bloom over several weeks on one plant. The flowers are perfect and honey-bearing, and are chiefly fertilised by the beautiful yellow flies belonging to the fly family called *syrphidie*, or hover flies.

Now, if you are taken by the fancy that the marsh marigold is a close relative of the marigold proper you are, strictly speaking, unable to tell the difference between a log cabin and the White House ; for the marigold proper is a first cousin to the daisy and is as far removed from the marsh marigold as any flower can decently be said to be removed from another. We shall marvel at the enormity of this mistake in a page or two when, with due reverence, we approach the royal family of the daisies and the true marigolds. For the moment, let us continue our stroll through the forms of the humble family of the buttercups.

Clematis (*Clematis vitalba*). This plant, sometimes called traveller's joy, climbs and twines like the honeysuckle. Sometimes the stems of clematis twine for more than twenty feet over a hedge. The young stems are purplish-green in colour, but become brown and hard in the course of the summer. The leaves are dark green and deeply veined, and consist of three widely-toothed leaflets. Flat clusters of small

greenish-white scented flowers unfold in July and August. Like the flowers of the marsh marigold they have no petals, but have the sepals coloured and playing the part of petals. The flowers are succeeded by quantities of seeds crowned with tufts of silvery down-feathered seeds, well suited to being carried long distances by the wind. These tufts of down have given this plant another popular name, "old man's beard." In winter these tufts are stripped off by the harvest mice, who use the down to make soft little nests as warm as feather beds.

**Anemone** (*Anemone nemorosa*). The wood anemone is one of the most beautiful of our spring wildflowers, and is found in woods and copses throughout the country. The leaves are of a rich dark green colour, and spring out from the stem upon stalks, three, four or five leaf-stalks springing from one point on the stem, growing out on different sides, forming a sort of ring of leaves. The leaves themselves are deeply cut into lobes. The graceful little flowers open out solitary upon the top of the stem—a pink-white flower with deep-yellow stamens and pale-green pistils. The anemone is one more flower that has no petals, only coloured sepals; and when these have withered and died, the fertilised eggs (ovules) below the pistils develop into a knob of tiny nuts.

There are many species of anemone wild in our woods. The pasque flower (*Anemone pulsatilla*) is a rare and beautiful anemone found in England only, southward from Yorkshire, with a strange purple-violet flower that grows from a woody root close to the ground. Like its common cousins the pasque flower has sepals only, no petals. The name is due to an old English custom of using these purple sepals for colouring Easter eggs.

**Columbine** (*Aquilegia vulgaris*). The wild columbine is very rare in a wild state. It is one of the most beautiful of all wildflowers. Having decided to have both sepals and petals, the wild columbine seems to have said to itself "a

thing that's worth doing at all is worth doing well," and straightway set about moulding the five sepals and the five petals into the loveliest possible shapes. The flower swings down, bell-like, and somewhat bell-shaped, from the curling top of a long and slender stem. Instead of being flat or gently curved, each petal is in the shape of a tiny cone, tapering up very small and ending in a little rounded point. These little cones are pointed up in the air like a cluster of spires on the tower of a cathedral, whilst the parts of the petals that hang down open out like the wide mouth of a boldly carved bell. Both petals and sepals are coloured—blue and pale purple in the common British columbine, scarlet and gold in the wild columbine of North America. Hanging from the centre of this gorgeous bell is what looks like a many-coloured tassel of countless coloured threads. This is really the cluster of stamens and pistils, thrust out to catch insects that reach up into the rounded petal points, where the nectar is kept. There are about fifty stamens, each with a tiny packet of yellow pollen at the tip. The thread-like pistils number five. This wild-flower derives its popular name from the fancied resemblance of the flower to a nest of doves, *columba* being the Latin for a dove. There are about seventy-five species of wild columbine, and many garden varieties have been produced by cultivation.

Other flowers in the great buttercup family include the following :

**Larkspur** (*Delphinium*). There are more than 150 species of the genus *Delphinium*, which includes a number of species of wildflower popularly called larkspur. The name delphinium comes from the word dolphin, from an imagined likeness of the flower to that fish. There are but two petals ; and the popular name larkspur is derived from the fact that these petals are combined into one, forming a spur. This rests within a spur formed by the calyx. The larkspur and delphinium blue are probably the most perfect blue to be found in flowers. There are many cultivated varieties.

**Peony** (*Paeonia*). The genus peony has five sepals and generally five petals, in some species a greater number of petals. The flowers range from deep red to palest pink : they have five petals and five or more sepals. There are many beautiful cultivated varieties.

**Baneberry** (*Actaea*). Sometimes called herb christopher, this poisonous plant has white flowers with four small petal-like sepals and four petals. The flowers give place to berries which are nearly black.

**Hellebore** (*Helleborus viridis*). One of the few green flowers in the world ; the genus includes many species with red, rose-pink and other colours.

**Monk's Hood** (*Aconitum*). Sometimes called wolf's bane, every part of this plant is poisonous, but especially the root. It has handsome dark blue flowers.

**Mouse Tail** (*Myosurus*). When the yellowish flowers fade the seed-case grows into a grey spike which exactly resembles a mouse's tail.

**Pheasant's Eye** (*Adonis*). This is a beautiful flower with bright scarlet petals (usually five, sometimes as many as eight). The petals are darker at the base. It grows as a weed in cornfields.

**Globe Flower** (*Trollius*). A large and pretty flower with about fifteen pale yellow sepals that close like a globe around the petals.

**Buttercup** (*Ranunculus*). And last—but by no means least—the buttercup itself. The buttercup has five or more green sepals, all separate from one another. Within this calyx rise and spread five or more yellow petals, also separate from one another. Within this corolla are many yellow stamens, and each bears an anther which contains two sacs of pollen. Each pistil has one egg-case containing one egg. All buttercups have a little

pocket on each petal in which nectar is provided to reward the insects that act as pollen-carriers.

There are several species that are lumped together popularly under the name buttercup. The commonest of these are three species called *Ranunculus bulbosus*, *Ranunculus acris*, and *Ranunculus repens*. The first of these is the real buttercup, because its flowers are more truly cup-shaped than the others, the petals remaining curled up like the sides of a golden chalice. In addition to the fine cup form you will notice that the green sepals turn down against the stem. In the other two species the petals open out more widely, like a flattish dish rather than a cup, whilst the sepals spread out with their tips as far away from the stem as possible. The root is usually of a grey colour and grows small bulbous swellings rather like tubers. The flowers are large and bright golden yellow. The stem and the leaves are hairy, the leaves growing in three lobes that spring from the tip of a leaf-stalk. They are wonderfully beautiful leaves, their edges carved like the decorations upon Gothic windows ; yet perhaps they are not quite so exquisite as the leaves of the second species, *Ranunculus acris*, which is sometimes called the meadow buttercup and sometimes the tall buttercup.

This meadow buttercup believes in being slender. The light yellow flowers sway upon the tips of long slender stems, like golden cups with thin green stems twenty times as long as the bowl. The leaves, too, are slender. They are deep green, cut into from three to seven lobes springing from one point on the stem. Each leaf is like a set of green spears richly decorated and set in a fan-pattern on the wall of an ancient armoury. The name crowfoot, often given to the whole buttercup family, was chosen because the leaves of several species were thought to be something like the spread-out claws of a crow's foot ; but no crow on earth ever possessed a foot so beautiful in outline as the leaf of a buttercup.

Many species of buttercup have two kinds of leaves—the delicately-shaped, many-pointed, wavy-lined leaves spring

off from the lower part of the stem, whilst from the upper part hang long simple finger-shaped leaves, or leaves long and ending in a point, like a pennant. The stems of most buttercups are covered with hairs, though often the upper part is smoother and less hairy than the part below.

The creeping buttercup (*Ranunculus repens*) gets the first part of its name from the long runners it sends creeping along the ground, like the strawberry plant. These runners send down rootlets which take hold of the soil wherever they go, and in this way the plant soon manages to spread over the fields and star them with gold.

With this brief sweep through the buttercup family we pass high over the rest of the 200-odd families of dicotyledon flowers, noting only that the buttercup family, in which there are about forty genera and more than 1,000 species, is a parent family from which sprang a great number of other flowers in the vast dicotyledon class : it is believed, too, that some of the monocotyledons are descended from *Ranunculaceae*. As our knowledge stands to-day, we can but vaguely contemplate the brilliant brotherhood of the plants, which clothe earth, not merely with green, but with every conceivable colour, with shades and tints of inimitable beauty, with scents of so bewildering a variety that no poor coarse human nose can ever explore them fully. It takes the whole population of the insect world to explore the scent of plants ; and we shall get a hint of that clamorous, buzzing multitude besieging the realm of petals and stamens and anthers in our next few chapters.

And not only are the green and the other colours and the sweet scents of our earth the gift of the brotherhood of the plants, but so also are those kindly fruits which we eat "in due season"—though man has so mastered the fruit tree and has so organised his transport that nowadays we can eat practically any fruit at any season of the year.

In passing on our way to the last and greatest family of the flowers let us again remember that it is the flowering of grasses and innumerable humble green inhabitants of the vegetable garden that provide the basis of all higher

life upon earth—all life of bird and beast and man : all the noisy spectacle of our own lives depends upon the silent trees and herbs that grow in myriads together in orchard and field.

## COMPOSITE OR DAISY FAMILY

(*Compositae*)

This is the biggest flower family in the world, having 1,000 genera and more than 12,000 species. It is also the " royal family " among the plants, considered by botanists to be the leading family of all. It is certainly the most " advanced " and complicated of the flowering plants. The *Compositae* includes common lawn and meadow flowers like daisy and dandelion, and great and lovely garden blooms like sunflower and chrysanthemum. Nearly all the species are herbs. Let us introduce ourselves to the princedom of the plants by one of the commonest members of this family.

**Common Daisy** (*Bellis perennis*). Chaucer was not far wrong in calling the daisy " Empresse and floure of floures all."

The name Compositae means " a composite thing " : that is, an arrangement of many things into one thing. Every common daisy is really a bunch of about 250 small flowers, called *florets*.

The daisy looks like a ring of white petals round a knobbly button ; but each " knob " in the " button " of the daisy is a perfect miniature flower, with five tiny petals, with stamens, a pistil, and an ovary (seed egg). Each " knob " of the daisy " button " is therefore called a " disc floret."

Each white " petal " of the daisy is also a complete flower, though having pistils only, thereby being a female flower. Each " petal " is called a " ray floret." If you will look at the " petal " of a daisy you will see that its base is


FEVERFEW
SCOTCH THISTLE
GOLDILOCKS
JERUSALEM ARTICHOKE
HEMP-AGRIMONY
DICOTYLEDONS + COMPOSITAE
CORALLA
SEPALS
OVARY
RAY FLOWER
STIGMA
ANTHERS
STYLE
FILAMENT
CORALLA
SCALES
OVARY
EMBRYO
SECTION THROUGH AN INNER FLORET
RAY FLOWER
DISC FLOWER
GREEN BRACT
THE PARTS OF A SUNFLOWER
A TYPICAL MEMBER OF COMPOSITAE
RAGWORT
PLANTAIN LEAVES LEOPARDS BANE
COMMON GOLDEN ROD
COLTS FOOT
GOLDEN SAMPHIRE
OX-EYE DAISY
DANDELION
COTTON WEED
CHAMOMILE
Jh

curled round a minute pistil, and its tip is cut into by notches which show that it is in reality several petals.

A marvellous economy is thus seen in the daisy—for its 250 little flowers work together for the good of the whole daisy. (Let us remind ourselves that the proper meaning of the word " economy " is : a right use of every part to the utmost, a waste of nothing that can be used.)

Of course the insects visit the daisies. The ray florets are spread out for the special purpose of attracting insects ; and the insects, marching over the velvety surface of the disc florets, become covered with the pollen from these tiny flowers. Much of this pollen will of course be brushed off into the pistils of the florets of other daisies, and in this way cross-pollination by bees is achieved by the daisies.

Yet there are sure to be some of those 250 florets which remain unpollinated. Here another piece of clever economy comes in. Every night, and when it rains in the day-time, the daisies close up. That is to say, the ray florets curl up and close round each other in the shape of a bud. In this position the anthers of the disc florets can touch the pistils of the ray florets, and the daisy achieves self-pollination for all those florets which have not been cross-pollinated by insects ; and this is the reason why daisies multiply so abundantly and cover the lawns and meadows with their white and glowing faces.

All over England and most of Europe, in the east and west of North America, daisies innumerable will be found blooming on almost every grass patch throughout the summer months, all day long. The word daisy means poetically the " day's eye."

The daisy keeps a fat store of food in its roots for the " rainy days " of winter no less than for a summer drought ; though in this respect perhaps the daisy is not quite so provident as its cousin the dandelion.

**Common Dandelion** (*Taraxacum officinalis*). The dandelion, being a member of the aristocratic family Compositae, is also a close-pressed bunch of tiny florets. Unlike those of

the daisy, however, the florets of the dandelion are all of one kind : they are all ray florets, with no disc florets in the middle. For this reason scientists put the dandelions into another class of Compositae.

The florets of the dandelion all have both stamens and pistil. They are of a bright yellow colour which succeeds in attracting to the flower as regular customers more than a hundred different kinds of flies, bees and beetles. The florets which are not cross-pollinated by these insects can be self-pollinated.

The dandelion has a beautiful and elaborate arrangement for dispersing its seeds, of which there are often two and three enormous crops each summer. When the petals fade and fall off leaving the ripened seed or fruit, each fruit ends in a point sticking upward, and attached to this beak grows a sort of lilliputian witch's broom. The " broom handle " rises, a delicate thread, to the " bristles," which are even finer hairs, and which spread themselves out in umbrella shape over the seed. When a wind springs up, it catches the under side of these " umbrellas " of hairs and lifts the whole seed out, and the seed rides away on the " broomstick," in very truth like a witch. Thus are the seeds carried over miles of country to lodge and grow in distant places. The whole cluster of " broomsticks " makes a light feathery ball, popularly called the Blow-ball.

There is another remarkable fact about the dandelion. Everyone who has had the job of keeping a lawn tidy will have been annoyed by the fact that the dandelions which spring up unbidden among the grass have their leaves in rosettes so close to the ground that they are cut only slightly, if at all, when the lawn-mower passes over them. Even the stalks on which the flower heads grow seem possessed of an uncanny power to dodge the lawn-mower. They bend very easily.

Full many a gardener has dropped angrily upon his knee-pads and plunged a trowel into the soil in a determined attempt to uproot the dandelion. The dandelion, being a cunning creature, pulls its leaves close to the soil by

contracting its roots. Nevertheless, there's a nice long root to store winter food in, so that the plant can endure long hard winters and blaze a yellow trail again across the lawn in March or thereabouts.

It is for good reasons, therefore, that gardeners call the dandelion "Yellow Peril," though the people of ages past, who called this gay, lovely, and highly developed flower "dandelion," got the word from the French *dent-de-lion*, "lion's tooth," probably to describe the jagged edges of its leaves.

The long roots, the soft furry flower stalks, and even to some extent the leaves of the dandelion, are filled with a soft milk-like juicy sap which is sometimes used in medicine. The root is ground as a substitute for coffee in some parts of the world; but in commercial importance the dandelion cannot compare with its big brother the lordly sunflower.

**Sunflower** (*Helianthus annuus*). The sunflower is a native of the Great Plains region of the United States, but on account of the value of its seeds, it was introduced into Europe and Africa about the middle of the sixteenth century. The seeds are eaten like nuts by many people, and the oil which the seeds contain is used in cooking, in the manufacture of varnish, soap and other things; and they also yield a yellow dye which is commercially valuable. The leaves of the sunflower are used as fodder for cattle. So there's not much that need be wasted of the sunflower!

There are at least 60 species of sunflower in the world, the common wild sunflower of the Plains having a hairy stem 3 to 15 feet high, and broad, coarsely-toothed, rough leaves 3 to 12 inches long, and 3 to 6 inches wide. The cultivated sunflower of the gardens sometimes attains a height of 20 feet and may have flowers 2 feet or more in diameter; ordinarily, in gardens in England and America, the sunflower does not grow to a greater height than 6 to 8 feet.

As with dandelions, each petal of the sunflower is really

a complete flower ; and their arrangement is on the daisy pattern, with ray florets springing out round the side and disc florets forming a " button " in the middle ; the sunflower therefore belongs to the first class of Compositae.

There may be about 20 or 30 ray florets in a sunflower. Some of these " petals " may be more than 2 inches across at the base, each petal notched at the tip. These gay golden banners attract insects from long distances, to visit the darker-yellow disc florets, the perfect flowers crowded closely together in the centre, 60 or 70 perhaps in a single sunflower.

**Lettuce** (*Lactuca sativa*). Talking of usefulness, none of the Compositae is more frequently found upon the dinner table than the leaves of the lettuce, which is a fairly simple member of the family. I say " fairly simple " because its yellow flowers contain fewer florets than almost any other species. Nevertheless, our garden lettuces are rich forms, with a long history of cultivation behind them. They are believed to be descended from a small wild species which once inhabited the islands of the East Indies ; but, as is the case with so many of the grasses which have been transformed into golden grains by the handiwork of man, no man can now find the original wild lettuce. Perhaps it, too, like maize and wheat, has wisely decided to exist only in a civilised state, though there are plenty of wild lettuces besides the species cultivated, and eaten with our salads.

The kitchen-garden lettuce has a leafy stem, oblong leaves, and flat little bunches of yellow flowers ; and to those who would look down upon a member of an aristocratic family for going into the kitchen garden, I would recall that it was no less a person than the Emperor Augustus who, attributing his recovery from a dangerous illness to the lettuces which he ate, built an altar and erected a statue to this cool and luscious vegetable.

Nor is the lettuce without character. The lettuce, being filled with a milky sap not unlike the juice of the dandelion, exudes this substance over its leaves occasionally, so that

destructive insects, such as ants, get stuck fast to the leaves, like flies on a fly-paper hung up by men. The sticky milk-sap will in time dry up, and the dead insects will fall off: sometimes they will get washed off by rain; but they will pursue no further their destructive attack upon the leaves of the lettuce.

Other flowers in the enormous Compositae family—one-tenth of all flowering plants are members of this family—include the genera:

**Hemp Agrimony** (*Eupatorium*). A vast genus of herbs, mostly American.

**Aster.** This genus includes the *Michaelmas Daisy, the China Aster* and *The Goldilocks.*

**Fleabane** (*Erigeron*).

**Antennaria.** Includes the *Mountain Everlasting.*

**Inula.** Includes *Golden Samphire* and *Ploughman's Spike-nard.*

**Burweed** (*Xanthium*).

**Chrysanthemum.** The word comes from the Greek *chrusos,* "golden," and *anthemon,* "flower." There are many species and varieties of this flower. Yellow and white chrysanthemums belong to a north African species. The *Ox-eye Daisy,* the *Corn Marigold* and the *Feverfew* also belong to this genus.

**Matricaria.** This genus includes the *Wild Chamomile.*

**Chamomile** (*Anthenis*). A genus including the *Common Chamomile,* the *Yellow Chamomile,* the *Corn Chamomile* and the *Stinking Mayweed.*

**Achillea.** *Sneezewort, Milfoil* and several other species.

**Cotton Weed** (*Diotis*).

**Tansy** (*Tanacetum*).

**Artemisia.** Includes the *Mugwort* and *Wormwood.*

**Coltsfoot** (*Tussilago*). Includes the *Butterbur.*

**Senecio.** Includes the *Groundsel* and *Ragwort.*

**Doronicum.** Includes *Leopard's Bane* and *Plantain Doronicum.* The latter is not the plantain of our garden lawns, which has the distinction of giving a name to a family of its own (*Plantaginaceae*).

**Burdock** (*Arctium*). A single species.

**Saw-wort** (*Serratula*).

**Saussurea.**

**Thistle** (*Carduns*). There are many species of thistle. The cotton or Scotch thistle (*Onopordon acanthium*), is said to be the emblem of Scotland, but another species, *Cirsium acaulis*, a stemless thistle common in Scotland, is probably a better species for this honour. The thistle called Burdock (*Arctium lappa*) has an edible root which is sometimes blended with the juice of the dandelion into the " soft " drink " Dandelion and Burdock."

**Centaurea.** Includes *Knapweed* and *Cornflower.*

**Goat's Beard** (*Tragopogon*). Includes *Salsify.*

**Ox-tongue** (*Helminthia*).

**Picris.** Includes *Hawkweed Picris.*

**Hawkbit** (*Leontodon*).

**Cat's Ear** (*Hypochoeris*).

**Sowthistle** (*Sonchus*).

**Hawk's Beard** (*Crepis*).

**Hawkweed** (*Hieracium*). Includes *Honeywort.*

**Chicory** (*Cichorium*).

**Lamb's Chicory** (*Arnoseris*).

**Nipplewort** (*Lapsana*).

**Jerusalem Artichoke** (*Helianthus*). Belongs to the same genus as *Sunflower*.

**Dahlia.** This genus includes *Zinnia*.

**Artichoke** (*Cynara*). A very close ally of the thistles.

**Marigold.** Last—but again by no means least—the marigold, the true marigold, so far removed in flower history from the marsh marigold which bobs in the water grass of damp meadows. The true marigold (*Calendula officinalis*), is now only a cultivated garden plant—a sunny, golden-yellow bloom of the daisy class, with ray and disc florets. The ray florets are female, the disc florets are male. Although the original wildflower of *Calendula officinalis* seems now to have vanished from off the face of the earth, there are several species of true marigold to be found wild in our land. The so-called African marigold, *Tagetes erecta*, and the so-called French marigold, *Tagetes patula*, are both natives of Mexico. The corn marigold, *Chrisanthemum segetum*, is a native of south Europe and north Africa, but is found growing wild in our cornfields as a weed.

In botany, any plant is a weed which persists in growing where man does not want it to grow ; though many of us would not care to see such weeds as the ember-red poppy (*Papaver rhoeas*—family *Papaveraceae*), and the gold-showering corn marigold swept away from our fields.

END OF BOOK TWO

# Book Three

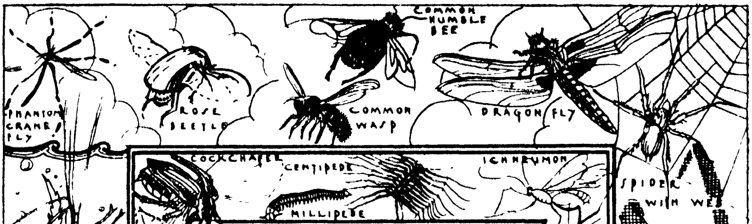
# A Simple Survey of Insect Life

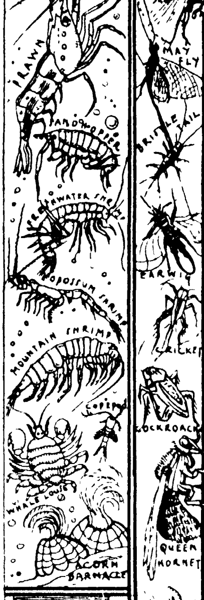
A plain description of the anatomy of insects, followed by an easy-reference account of the orders and families in the insect world. The story of the evolution of social life among insects, with the life in bee-hives and ant-hills out-lined. Biographies of wasps, earwigs, dragon-flies, daddy longlegs, moths, butterflies ; with the full story of insect metamorphosis.

The place of insects in the world of nature : insects as pests and bearers of disease : useful insects : the mysterious and beautiful relationship of insects and flowers : the enemies of insects.

Aquatic insects : may flies, caddis flies, gnats and water-gnats, water beetles, aquatic moths and others.

These are among the many types and aspects of the strange department of natural history dealt with in detail in this book.




# PHYLUM · ARTHROPODA ·

## TWO CLASSES

| CRUSTACEA | INSECTA |
|---|---|
| SIX FAMILIES | FOUR FAMILIES |

More than half the known species of animals in the world are included in this phylum of insects alone there are very many more species than of all other animals taken together— All these creatures have a body enclosed in a series of rings or body segments with paired jointed limbs which enable the Arthropods to have an active & varied life These segments are composed of a hard horny material called chitin (Greek <u>chitōn</u> 'a tunic') which forms an <u>outside skeleton</u> which is periodically shed & replaced

It seems likely that Arthropods have evolved in the course of ages from the segmented worms


# CHAPTER I

# WAR AND PEACE IN THE WORLD OF NATURE

WE HAVE SEEN that flowers send forth scents in order to attract honey bees to them, and they shine with bright colours so as to induce the bees to land upon them, and they provide safe landing places for bees, and signposts to guide the little winged animals to the nectar. On the way to the nectar the flowers set up spring gateways and a thousand and one devices to ensure that the bees become dusted with pollen and give up to the stigmas the pollen with which they are already dusted.

Flies, not being so intelligent as bees, but coming next in order of usefulness for cross-pollination, are tricked into pitfall flowers, prison flowers, pinch-trap flowers, flowers which send forth the odours of bad meat, of which many flies are inveterately fond. . . .

We have seen that flowers have special hours of opening, and open and shut with the regularity of shops, in order to ensure, as far as possible, that insects will visit blooms of the same species. Many flowers, indeed, are shaped so that none but certain species of insect can visit them, as in this way cross-pollination is yet more assured : the moth flowers, which open at dusk when moths take wing, have their nectar hid at the base of tubes which are too long for the tongues of bees. The butterfly flowers, such as the pinks, also have nectar tubes too long for the tongues of bees.

Does all this mean that flowers are aware of insect life about them, as we asked once before in this book ? Does it mean that those strange monsters, the plants, are all the

while aware of the ways of life of insects, and can make use of insect-ways with a certain amount of conscious purpose? This is a question to which no sort of scientific answer can be given; but it is not a foolish, "romantic" question; and there is no reason why scientists should not one day answer it.

Let us pose the question the other way round:

Are insects aware of plants?

In this case our first impulse is to answer "yes." But that is only because we, as human beings, are nearer to insect life than we are to plant life. Or we imagine we are, at any rate; because insects have eyes, and can see plants, they can move and touch plants, and, being of the animal order of creation, insects, like men, eat by destroying other lives, and not by making their food out of dead stuffs as plants live.

If you look at the problem of cross-pollination closely, you must be struck by the fact that the real design and cleverness lies within the flower; and many an insect rushes into the nectary within the shining coloured petals, just like a man going in to get a drink at a brightly painted saloon bar.

This is not always the case. There is the extraordinary instance of a little southern moth, *pronuba*, popularly called the yucca moth. The yuccas, or Spanish bayonets, are monocotyledonous plants of the lily family, and are found over wide areas in the southern United States and Mexico. There are several species of yucca plants and every species has a species of yucca moth specially adapted to it. The yucca plants depend entirely upon yucca moths for cross-pollination: their pollen is too sticky to be blown by the wind, too heavy to cling to the backs of other insects; and the flowers are so built that self-pollination is impossible. But that is not all. The yucca moths are also entirely dependent upon the yucca plants for the rearing of their young.

The female yucca moth has a sharp pointed tail with which she pricks a hole in the *seed-case* of the yucca plant;

and through that hole she forces two or three of her eggs, which lie snugly side by side with the eggs of the plant. The yucca moth then goes to the stigma of the flower and places in it a ball of pollen she has collected from other yucca plants of the same species. Thus she pollinates the flower. This pollen, sinking down upon the plant's eggs, fertilises them and produces seeds. These seeds develop side by side with the eggs of the yucca moth in the seed-case. When the young (or *larvae*) of the moth break from the eggs they begin to feed upon the seeds. They do not eat all the seeds ; and by the time the seed-case splits, several seeds escape with the larvae into the world.

There are several interesting facts to note about this curious adaptation. The yucca moths are unique among all the thousands of moths and butterflies in the world in having arms for the special purpose of gathering pollen. All other insects which gather pollen bite it off and eat it, or brush it into a little pouch in their sides which is provided for it ; but *Pronuba* gathers a great bunch of pollen in her arms and stuffs it into the stigma of the pistil. If she did not cross-pollinate the flowers in this way the plant's eggs would not be fertilised and the moth's babies would have no seeds to feed on, and would starve. The parent moth never eats any pollen or sucks any nectar from the plant.

It is hard for us to imagine that this little insect, the yucca moth, does not know all about cross-pollination, and does not act intelligently, for the good of her young, and with a proper sense of the good of the plant also. Even if that seems to you to be a fairy tale, you will be hard put to it to find any other explanation of the facts—unless, of course, you regard all creatures in the world of nature as being machines, obeying laws of which they have no knowledge.

However scientific we try to be, thoughts about these matters constantly stir in our minds when we contemplate the world of nature. Science is a hard taskmaster and bids us never make up our minds from any wish or fancy, from any hope or faith ; but to submit our minds to the discipline

of facts, and to draw from those facts only those conclusions which are as certain as that $2+2=4$.

Although the case of the yucca moth is unique, it is an important case. In more normal instances the adaptation of plants and insects to one another is far less perfect, though there are many cases where insects are dependent entirely on certain plants, and hundreds of cases where plants are dependent on certain insects.

As an example of a common insect, in our own land, who is entirely dependent on a plant, we may take the flag beetle (*Monsychus vulpeculus*). This insect passes its entire life on the blue flag (*Iris versicolour*). This small beetle, which belongs to the group of beetles called weevils, feeds on both the pollen and the nectar of the blue flag, and it sometimes eats the petals and sepals as well ! The beetle lays her eggs in the seed case where the larvae feed on the ripening seeds ; but since the beetle stays on the flag when it is grown up, and never cross-pollinates, it is nothing but a parasite on the plant.

There are countless instances of flowers that are so dependent upon the visits of bees that, if bees fail to cross-pollinate them, the flowers do not produce seed. This is the case with red clover, larkspur, some orchids, and a host of others. For instance, in the great pea and bean family (*Leguminosae*)—we have glanced at gorse and broom in this family—there are at least thirteen species which can only grow where bees are, and which die out when they are not cross-pollinated by bees. Red clover (*Trifolium pratense*) belongs to this family, and is chiefly pollinated by bumble-bees ; and is therefore called a bumblebee-flower. In the absence of bumble-bees this valuable fodder plant yields little or no seed. Not until bumble-bees were imported into Australia and New Zealand could the farmers there cultivate clover. Ordinary honey-bees have a tongue six millimetres long. The nectar of red clover is hid in a tube nine millimetres down. Some of the larger bumble-bees have tongues twelve millimetres long.

The honey-bees are quite as dependent on the flowers

they visit as the flowers are dependent upon them ; for not only do they feed on nectar themselves, and make honey from it in vast quantities for their winter needs ; they also feed their young on pollen. Pollen is the " baby food " of bees. Bees are thus wholly dependent on flowers, both for food for themselves and their families. Honey-bees, however, are not dependent on any one species of flower, but visit a vast variety of blossoms throughout the season. We cannot say that there are any special honey-bee flowers.

If we could stop at this point we might feel inclined to say that, whatever the truth about the matter might be, the mysterious communion between plants and insects is a most beautiful thing, in spite of the parasitic habits of the flag beetle. Unfortunately we cannot stop at this point. As a matter of fact, the vast majority of insects in the world are enemies to the plants. In our chapter called " The Forest " we briefly encountered the bark beetle and the gypsy moth ; and the story of the gypsy moth's adventures in North America may well serve to show us that the relationship between plants and insects is not all honeying.

" Back in 1869 a French scientist, Trouvelot, was conducting a series of entomological[1] experiments at his home at Medford, Massachusetts. For the purpose of his experiment the scientist imported from the Old World a number of hardy moths, among these being one well known in Europe, England and Japan. In colour, the male of this particular species is a yellowish buff or brown, about the shade of a gypsy's face—hence the name, ' Gypsy moth.' Little did Trouvelot foresee the disaster that was to follow. . . .

" The trouble began one day when a puff of wind blew from a window-sill of Trouvelot's home a small pasteboard box containing a few score eggs of the Gypsy moth. A veritable Pandora's box ! . . .

" Ten apparently harmless years passed. Another five years, and entomological observers were noticing the presence of strange caterpillars in the vicinity of Boston. A few years more, and in some sections Gipsy moth

[1] " Entomology," from the Greek word for insect.

caterpillars appeared in such numbers that the trees were stripped bare of their foliage !

" Caterpillars by the billions ! Villages were overrun ! Sidewalks were slippery with their crushed bodies ! They crawled into houses. They made their appearance at dinner tables !

" Then war was declared !

" And this war has been going on for thirty-five years. The determination of this invader is to eat the leaves off all the trees in New England, and then push on and find more worlds to conquer. Since leaves are the lungs of trees, death follows in the wake of repeated defoliation. How far this voracious horde will get, and in what numbers it will go, depend upon the skill and scientific strategy of the defenders. . . .

" It is one of the greatest wars against a single insect that the world has ever known. Never before has man set himself to battle so vigorously with one species, training armies of scouts and quarantine inspectors, developing costly apparatus for applying poison sprays, spending millions a year on the contest, employing all the science at his command ; importing, breeding, encouraging other species to battle with the menacing moth !

" What will the outcome be ? Upon the outcome hinges the destiny of a nation ; the fate of its agriculture, its orchards, its forests ; the comfort, prosperity and happiness of all its inhabitants."[1]

Now, why should an insect become a pest merely because it is introduced into a foreign land by mankind ?

To answer that question we must turn back to the end of Chapter IV, Book One, where we dealt with the fate of the poor little crab in the clutches of the octopus, and we saw the hunting of the squids, and the fate of the squids in the jaws of the squid-hunting whales, and of the baby squids in the beaks of the sea-birds. We saw then that, although one species of creature preys upon another, a " balance of nature " has been reached whereby no species is completely

[1] M. K. Wisehart, *Marvels of Science*, pp. 209–12.

eaten up and destroyed. The squids do not destroy all the fish in the sea, although they might do so if birds did not eat millions of young squids, and if squid-hunting whales did not eat millions of grown-up squids.

If you cast your eyes over the whole of the great watery jungle of the oceans, and over the great land jungles of Africa, South America, India and the East ; and if you take a bird's eye view of the wild life of the temperate regions of the earth : in fact, if you contemplate all the growing, fighting, feeding forces of the world of nature, you must see that a " balance of nature " strictly rules among the eaters and the eaten. All those species which are too easily eaten, are soon eaten off the face of the earth !

Nor does this " balance of nature " come about only between different sorts of animals : it must also come about between those animals that eat plants and the plants they eat.

We saw in our chapter on " the forest " that there is war among the creatures that attack trees. Half the insects in the world live by eating plants. Luckily for plants, the other half of the insect population lives by eating insects. Which may enable us to understand why the gypsy moth became a pest when it was taken to America by Trouvelot. . . .

In its native lands the gypsy moth is kept down by its natural enemies. Indeed, in the lands where it lives by nature, in Europe, in England and in Japan, an average of 90 out of every 100 gypsy moths are destroyed by their natural enemies. These natural enemies do not exist in America, and so the gypsy moth threatens the forest land of the whole continent.

In a state of nature, such a terrible invasion by a pest would not be so likely to take place ; for species arise amid enemies and fight their way to a position which they are only just able to keep. But man has come to lord it over the rest of the natural world ; and man has gone about upsetting the balance of nature everywhere.

Man has planted vast orchards of fruit trees. He has sown gigantic plains with cereals. By doing these things he

has altered the natural vegetation of his lands, and this has had a strange, unwanted effect upon the insect population. It was an accident that the case of gypsy moth's eggs should be blown off Trouvelot's window ; but it was almost inevitable that insect pests such as the green-fly (*Aphides*) and the corn borers should become pests in man's orchards and cultivated fields. Look at it from the insect's point of view—

An insect wings his way along and comes to a great orchard or a vast cereal crop. Nowhere in wild nature can such a marvellous collection of one kind of tree or one sort of grass be found. Nowhere in nature can such luscious fruit be found or such rich and nourishing grain. The insect happens to like these articles of food quite as much as man likes them : so the insect settles in the orchard and the grainfield and has a family, and every son and daughter he has in time sets up a family also, and there, amid millions upon millions of rosy apples or ripening pears, and in among myriads of swaying golden ears of grain, the insects multiply as they could multiply nowhere in the wilds of nature. Their natural enemies of the tanglewood and jungle have been cleared away by man when he felled the trees and stripped the ground of weed and underbrush.

The fact that certain insects occur in such numbers as to reach the status of pests is due to mankind upsetting the balance of nature by cultivating great quantities of one kind of plant over large areas. The continent that has suffered most in this respect is probably North America.

In Europe, North Africa and Asia, man has cultivated his crops for many centuries, and, although pests of insects are not unknown in those lands, a new balance of nature has in part been arrived at between crops and insects. In the New World, agriculture is practically a new thing : at any rate, the white man has introduced so many new crops on so vast a scale in North America that certain insects have multiplied so abundantly that a large proportion of every crop is destroyed by insects every year.

Many native insects have been provided with an almost

unlimited food supply, and invaders such as the gypsy moth have been given a land free from enemies. Like the human immigrants, these foreign insects have found America a "land of promise," but their nature makes them a threat to the civilisation of man, for they can but destroy what man creates. It is said that the work of a million men in North America is destroyed every year by insects.

Not only in America, but everywhere that man plants and ploughs, the insects arise to fight with him for possession of the earth. "In the British Empire the insect army is daily destroying life and property on a scale that no human enemies of ours have ever achieved in warfare. Insects, besides, are spreading, and are the only means of spreading, malaria and other diseases that kill not by the thousand but by the million every year, and keep whole populations of men unhappy and backward.[1] Of the entire agricultural produce of our Empire, the insect army destroys at least one tenth every year. In India alone the loss of crops, of timber and of animal products by insect damage is estimated at over £150,000,000 annually, and the death-roll due to insect-borne disease at over a million-and-a-half lives.

"If human enemies were destroying our lives and property in that degree, or to one thousandth part of it, the whole nation would be mobilised to fight them, and it would be the commonest and most laudable ambition among our young men to fit themselves for the struggle."[2]

Taking the population of the world at a round figure of one thousand million, we should be able, if it were not for our insect enemies, to feed and clothe *with our present resources* no less than a *hundred million more human beings* than is at present the case ; for *insects destroy* 10 *per cent of all crops.*

It has been well written, "We can see clearly that the insects are man's rivals for possession of the entire planet.

[1] We shall observe rather more closely the relationship between insects and human disease when we deal separately with the insects which carry disease germs. *See* Mosquito, Flea, etc., in following chapters.

[2] Sir Walter Morley Fletcher in his talk on "Biology and Statecraft." Seventh National B.B.C. Lecture.

They have ever been man's inveterate foes ; and they are damaging us infinitely more to-day than at any time since civilisation began."[1] They are damaging us to-day because there is more agriculture to-day.

We may close this chapter by noting that men have discovered one sovereign way of combating insect pests—and that is nature's way. By breeding the natural enemies of the pests and setting them loose in the infested orchards and fields, many crops have been rid of the pests.

Man has, in fact, set the insects which eat insects against the insects which eat plants !

In the course of our brief review of the earth's insect battalions, we shall observe some fierce battles in this world-wide war of insect *versus* insect and of insect *versus* man ; but we can come to see these battles clearly only if we understand what an insect really is.

[1] L. O. Howard, of the Bureau of Entomology of the United States Department of Agriculture.

## CHAPTER II

# THE FANTASTIC WORLD OF INSECT LIFE

THERE IS WAR for possession of the earth between the two highest types of living creatures—war between human beings, the highest vertebrates (backboned animals) and insects, the highest invertebrates (animals without backbones). It has been said that if insects could have grown up to be the size of men, no men could ever have been born upon earth, for insects have powers of adaptation to earth's varied conditions, which may well be the envy of human beings.

Perhaps insects are kept small by the very fact of their being invertebrate. Instead of having a skeleton of jointed bones built around a backbone inside a body of flesh and skin, insects have an outside shell of hard horny stuff similar to the shells of their sea-cousins whom we met in Book One. We saw how hard it was for the crab to grow up, and in what a sad, soft, unprotected condition he was between casting one hard shell and waiting for another larger shell to form. The insects are also troubled with these stern conditions of growth, though they have adapted themselves to living in small-size bodies. Their very smallness has in large measure assisted them in their progress to the top of the invertebrate class. It has aided them to develop powers of flight—for, obviously, a tiny, light body is easier to fly than a body as heavy as that of a man ; and their smallness has enabled them to creep in where no other many-celled creatures could possibly go.

So it is that insects have spread over nearly the whole

surface of the globe. They are found amid the arctic snows and the ice-fields of glaciers, and they teem in the tropics in infinitely greater abundance than all other forms of life, except bacteria. They swarm in the air over all the land masses and islands of the earth. Myriads dwell in and upon the soil, myriads more live happily for a large part of their lives buried deep in the wood of living trees. Masses of them live on the skin and fur of vertebrate animals, and some of them at certain stages of their life live as parasites within vertebrate and invertebrate bodies. They crowd the surface of inland lakes and ponds and streams and dive the waters and creep and crawl over muddy river beds. Some of them have set up their homes in hot springs where water is naturally on the boil, others inhabit the depths of wells, and yet others live in caves where no daylight has ever penetrated.

This amazing variety of *habitat* is as nothing compared with the marvellous body-forms and ways of life by which insects are enabled to dwell in these places. In the following pages we shall be able to glance but swiftly at a few of the physical marvels of insect life, and peer in but for a moment at one or two of their civilisations. These insect civilisations are older than the oldest civilisations of man, they combine the most sublime ideals of Utopian writers with the most fiendish aspirations of cruel tyrants.

How strongly have the insects established themselves upon the earth ! There are said to be round about ten million species of them. The largest collection of insect specimens in existence is at the British Museum (Natural History building, South Kensington, London), in which there are about eight million of these little creatures pinned upon cards in glass-topped drawers, with their Latin names and notes about their bodies and life-habits written up beside them. This collection, however, probably does not have examples of half the actual species in existence in the world.

The scientists have grouped insects into twenty-three chief orders, a list of which we give on page 305. The orders are

divided into families, the families into genera, the genera into species. The whole vast mass is termed the class **Insecta**,[1] and is tucked away inside phylum Arthropoda.

This word, *insect*, means " cut into." Every insect appears to be cut into three parts (1) the head, (2) the chest or *thorax*, and (3) the stomach or *abdomen*. These three parts are joined together by a neck and a waist which are in many insects as thin as threads—mere couplings, as small by comparison with the rest of the insect as the couplings joining two railway waggons. These three divisions in insects' bodies are ringed into segments which recall the segments of the annelid worms, from whom in all probability the whole arthropod phylum of creatures is evolved.

As in the annelid worms, some of these rings in the body parts of insects bear one or more pairs of limbs—legs, wings, or antennae. No part of an insect is more mysterious than the antennae, which spring from the head. These antennae are rod-like feelers made up of numerous jointed segments. (More segments! Insects are constructed on a chain pattern of small and large segments.) In some insects the antennae are pointed like spears, in some they are thickened like clubs, in yet others they are toothed like combs : there are antennae that spread out like fans of fine hairs. Almost endless are the varieties of antennae springing from the heads of insects, but their structure is no more varied than their use. In some insects the antennae appear to be simple feelers, sensitive organs of touch, nerve-filled arms that wave and touch objects in which the insect is interested. Again, the antennae are sometimes the organs of smell ; and in certain cases it is believed that they are like radio aerials, organs for sending forth and receiving messages from fellow insects.

Next in wonder and importance upon the head of an insect are the eyes, the marvellous compound eyes to which reference was made when we first encountered them down by the sea-pool.

[1] For the relationship between the insects and their sea-cousins, see illustration called " Phylum Arthropoda," on page 286.

The compound eyes of insects are built up of six-sided cells, one on top of another, pillars of eye-cells bevelled off to form two big half-spheres ; each half-sphere being an eye.

The sections making the pillars of cells in the eyes of insects are like nothing so much as the " eye cells " of leaves laid on top of one another so as to send the shafts of light through to the nerve-cells that connect with the brain of the insect.

The eye of the cockroach has eighteen hundred of these pillars of six-sided eye-cells. The eye of the house-fly has about four thousand, whilst some dragon-flies have as many as twenty thousand.

You may very well ask : how does an insect with 20,000 eye lenses *see* ?—for of course there are 20,000 images of objects reflected in the dragon fly's eye. It is believed that each pillar of eye-cells reflects what is immediately opposite to it, so that each pillar of those thousands of pillars gives to the fly's brain an impression of a different bit of the outer world. Perhaps all these bits are in some way put together in the brain of the insect, to make up a complete picture of the outer world ; in which case, the fly sees a far wider panorama of the outside world than the human eye can see. But we do not know what goes on in an insect's brain, and it may be that he gets a mere sensation of moving objects and of colours and lights and shades.

These pillars of eye-cells are separated from one another by layers of pigment cells, and in certain species of insect when darkness falls these pigment cells shrink back, allowing the eye-cells to touch and the images of the outer world to blend into one great image. These species of insect are thus enabled to gain a better view of the world in semi-darkness than in bright daylight, and this is the way in which night-flying moths and fireflies can see in the dark. Many of these nocturnal insects have so perfected night-sight that they are " day-blind."

From the head, we turn next to the chest or thorax, from which spring the legs and wings. We shall have to

look at examples of insect leg and wing when we examine separate families and genera of species in the next chapters, as the form of these limbs varies very greatly indeed. The abdomen, too, which is the third segmented section of insects, can best be studied when we deal with certain sorts of insect life around us. We shall then come to appreciate more strongly what a marvellous thing the body of an insect really is ; but before passing on to a view of wasps, bees, ants, flies and some more examples of the creeping, crawling, flying multitude, one more marvel must be looked at here—the amazing way in which certain insects are born into the world and grow up to perfect insect-estate.

The idea of creatures changing their forms has always fascinated mankind. The myths of the ancient gods told how they changed into animals, and the folk lore and fairy tales of all lands and times have related how kings were changed by devils and witches into wild animals, and princes were turned into dragons, princesses into swans, and pumpkins into Cinderella coaches.

We know of course that transformations just as marvellous as this take place in the world of nature every day —tadpole into newt and frog, caterpillar into chrysalis, chrysalis into butterfly ; and nature's transformations only seem to us less dramatic than fairy-tale spells because there is no wicked demon waving a wand in the background.

The butterfly mother lays her eggs upon the green leaf of a plant or tree. The eggs of butterflies vary in shape according to the species, and the eggs of some species are beautifully decorated with regular patterns in relief. Out of the egg comes a minute caterpillar, which begins to eat the green leaf. Some butterfly-caterpillars begin by eating their own egg-shells by way of *hors d'œuvre.*

The caterpillars of most butterflies complete their growth in a couple of months : those of the goat and leopard moths, feeding in the wood of living trees, grow slowly throughout several years before changing into the final form of the perfect insect.

When the caterpillar throws off its last skin the chrysalis

form reveals the wings, legs and antennae covered by a protective coating of varnish. The inside organs of the caterpillar have been broken up into a pulpy or fluid condition so that they may all be built up again upon a different plan. The changes inside a chrysalis between caterpillar and insect stage are such changes as would have to take place in converting a motor tractor (caterpillar tractor, say !) into an air liner. The chrysalis is the " hangar " in which this conversion is achieved.

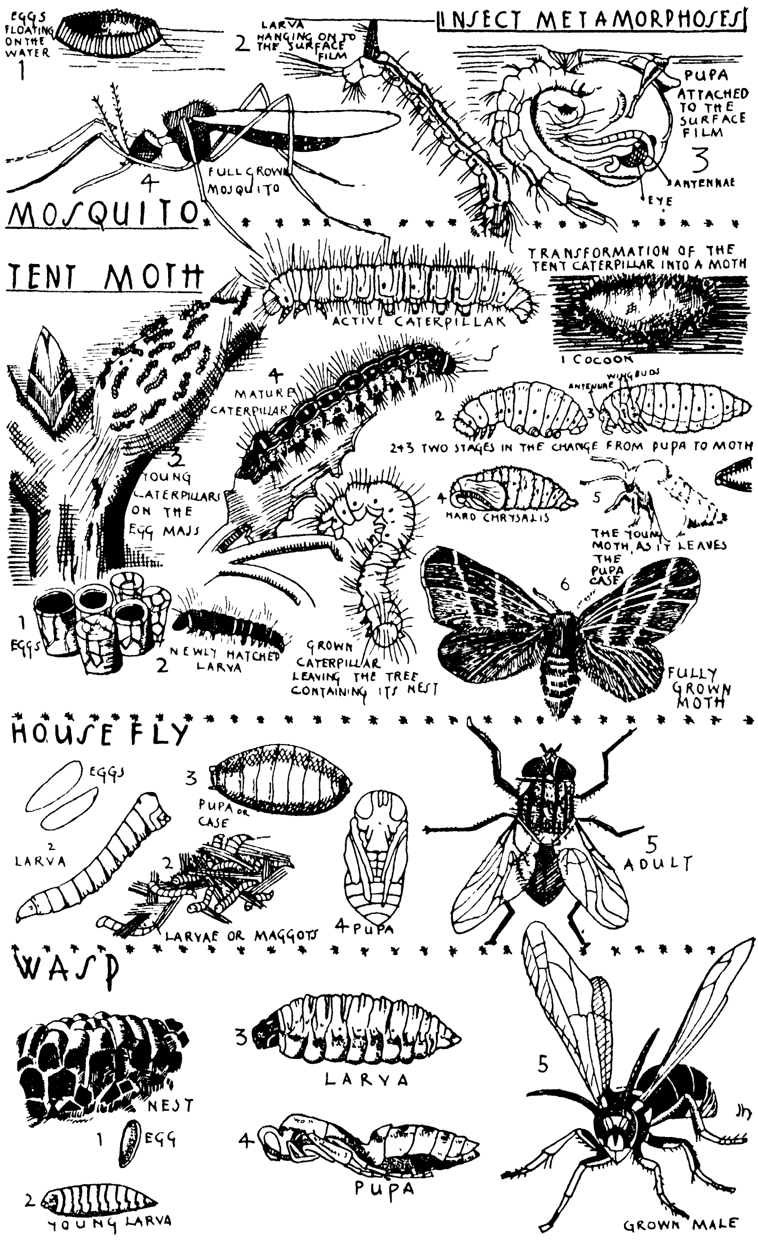
The caterpillar jaws that had been biting leaves and cutting up the green leaf protoplasm are of no use to a butterfly, which feeds by sucking nectar from flowers, so a tube mouth has to grow in place of a biting mouth, and the digestive organs must be replaced also to digest the new liquid food.

In addition to the rebuilding of the legs from the small five-jointed feet of the caterpillar, the four large wings, with their covering of countless microscopic scales have to be evolved, with suitable muscles to work them. The compound eyes also have to be developed.

When all these, and many other transformations, have been completed, the skin of the chrysalis splits, and the soft and colourless butterfly walks out and clings to the plant, remaining still until its flabby, crumpled wings have smoothed themselves and expanded and the legs have become hard and ready for use. The colour appears and deepens on this youngest butterfly, like the lights and shades of a photograph appearing upon the negative.

An easy example of metamorphosis[1] among the flies is the well-known daddy-longlegs, or crane-fly. No doubt at one time you wondered why this insect walked upon legs like stilts, which are clearly a hindrance to it when it crawls over a table or ascends the sloping top of a desk. One is apt to forget that the home of man is not the natural *habitat* of this insect ; and if you have seen one of these

[1] The word " metamorphosis " means simply " change of form." A more detailed account of the form of the caterpillar, and the weaving of the cocoon to house the chrysalis, is given in Chapter IV.


INSECT METAMORPHOSES
EGGS FLOATING ON THE WATER
1
LARVA HANGING ON TO THE SURFACE FILM
2
PUPA ATTACHED TO THE SURFACE FILM
3
ANTENNAE
EYE
FULL GROWN MOSQUITO
4
MOSQUITO
TENT MOTH
TRANSFORMATION OF THE TENT CATERPILLAR INTO A MOTH
ACTIVE CATERPILLAR
1 COCOON
4
MATURE CATERPILLAR
WING BUDS
ANTENNAE
2
3
2+3 TWO STAGES IN THE CHANGE FROM PUPA TO MOTH
3
YOUNG CATERPILLARS ON THE EGG MASS
4
HARD CHRYSALIS
5
THE YOUNG MOTH AS IT LEAVES THE PUPA CASE
6
1
EGGS
2
NEWLY HATCHED LARVA
GROWN CATERPILLAR LEAVING THE TREE CONTAINING ITS NEST
FULLY GROWN MOTH
HOUSE FLY
EGGS
3
PUPA OR CASE
2
LARVA
2
LARVAE OR MAGGOTS
4 PUPA
5
ADULT
WASP
NEST
1 EGG
2
YOUNG LARVA
3
LARVA
4
PUPA
5
GROWN MALE

creatures in the field you will realise the value of long legs in long grass. Let us watch a mother daddy-longlegs laying her eggs.

The female daddy-longlegs may be distinguished from the male of the species by her sharp-pointed tail. With this point she makes a hole a quarter of an inch deep in the ground into which she deposits one black egg. Then she strides on through the grass and makes another hole and deposits another egg. In this way she may lay several hundred eggs over several square yards of grassland. In the springtime these hatch out into dirty-looking, footless grubs of cylinder shape, which are known to the agriculturist and the gardener as the hated "leather-jackets," grubs that eat the roots of grasses and other plants, so that the green parts wither and die.

When patches of grassland go brown and bare in the early spring, it is probably because they have been eaten by the grubs of daddy-longlegs. The rooks and starlings know the sign, and fly down upon these bare patches, piercing the lawns and meadows with their sharp beaks to get at the succulent grubs. In this, as in so many other ways, these birds prove themselves the friends of man, in saving many a valuable green field from hurt by the leather-jackets.

The grubs that escape become in due time long chrysalids with the future wings showing plainly in their wrappings, and the body ringed at every joint with stiff bristles that aid them to wriggle forward. A pair of curved hornlike processes stand out behind the head-parts, admitting air to the developing daddy.

And then one day in the summer the metamorphosis takes place. The chrysalis splits, and the perfect cranefly steps out, stretching his long legs, unfolding, flapping and drying his crumpled wings.

## *THE TWENTY-THREE CHIEF INSECT ORDERS*

With some representative families within those orders.

| | |
|---|---|
| **Aphaniptera**<br>(" The wingless ") | The fleas. Four families. |
| **Diptera**<br>(" The two-winged ") | This is the order of the great group of flies, which includes crane-flies, mosquitoes, midges, gnats, house-flies, blowflies, hover-flies, horse-flies, fruit-flies, tse-tse flies, etc. About 60 families altogether, and many thousands of genera. |
| **Hymenoptera**<br>(" The joined winged ") | Honey-bees, bumble-bees, solitary bees, solitary and social wasps, ants, ichneumons, saw-flies, horntails, etc. Altogether nearly 50 families. |
| **Strepsiptera**<br>(" The twisted winged ") | One family of minute insects parasitic on hymenoptera and hemiptera. |
| **Coleoptera**<br>("The sheathed winged") | Beetles. This vast order contains more than 70 families, each of which includes many genera, some of which genera have a great number of species. |
| **Lepidoptera**<br>(" The scale winged ") | The order of the moths and butterflies, containing about 60 families and many thousands of genera and species. |

| | |
|---|---|
| **Trichoptera** (" The hairy winged ") | Caddis flies, etc. Twelve families. |
| **Mecoptera** (" The long winged ") | Scorpion flies. Three families. |
| **Neuroptera** (" The nerve winged ") | Alder flies, lace-wings, ant-lions, etc. Ten families. |
| **Hemiptera** (" The half-winged ") | Plant bugs, water boatmen, bed bugs, assassin bugs, scale insects, cicadas, aphides, etc. About 30 families. |
| **Thysanoptera** (" The fringed winged ") | Includes 3 families of insects popularly called thrips. |
| **Odonata** (" Toothed " or " Tusked " insects) | The order of the dragon flies and damsel flies contains 5 families. Inhabit inland waters. |
| **Ephemeroptera** (" Lasting but a day ") | The order of the May-flies. |
| **Anoplura** (" The unarmed tailed ") | The order of the lice. Three families. |
| **Psocoptera** (" The gnawers ") | Two families, that of the wingless book lice, and of the winged psocids, that dwell in trees. |
| **Embioptera** (" The lively ") | A small group of tropical insects. |
| **Isoptera** (" The equal winged ") | The termites or so-called " white ants." They are not white nor are they ants. |

| | |
|---|---|
| **Plecoptera** (" The plaited winged ") | Stone flies. Four families. |
| **Dermaptera** (" The skin winged ") | Earwigs. |
| **Orthoptera** (" The straight winged ") | Cockroaches, grasshoppers, locusts, stick insects, praying mantis, crickets, etc. More than 10 families, and a great many genera and species. |
| **Collembola** (" The spring-tailed ") | Four families. |
| **Protura** (" The simple tailed ") | Very minute and primitive insects. |
| **Thysanura** (" The Bristle-tailed ") | The most primitive of living insects. Wingless and very minute. |

# CHAPTER III

# SOCIAL AND SOLITARY INSECTS

UNTIL THE OTHER DAY I did not dream that there could be beauty in stuffed animals arranged in glass cases in a museum ; and then, when I was in the Natural History Museum, and had passed through the great central hall, where the African and the Indian elephants stand ponderously, and had gone down the corridors where the families of birds are poised upon wires and strings behind glass, and had walked through the quiet well-polished rooms of the prehistoric wing, where the giant sloth rears his old bones against the broken trunk of a tree, and the footprints of the prehistoric reptiles are seen splayed in the fossilised mud—when I had tramped up the staircases along the galleries where the giraffes strain their stuffed necks to the top of their tall cases and the antelopes with long branched horns look at you threateningly, past the solitary case where the white tiger snarls and glows, and into the Lower Mammal Gallery, where the ranks of bison, buffalo, deer and wild sheep stand in the splendid silent strength of their prime, grouped according to their families, genera and species. . . . I became aware of another species of creature whose spirit brooded over the vast orderly arrangement, a creature who was in quest of knowledge. There were but miserable specimens of this creature in one or two glass cases in the Upper Mammal Gallery—they faced across to the far more magnificent specimens of gorilla and orang-outang : it was nevertheless this other creature whose spirit I met face to face, at every turn in the great echoing building.

I was aware of the kindly triumph of man blessing the brute creation. The triumph of man was seen in his ordering

of the creatures in the science of life, and none save a kindly creature, a beauty-lover, a glorifier of knowledge for its own sake, could have achieved this arrangement of creatures according to their species, genera, families and phyla. . . . It was recorded that Adam named the animals in the beginning, and here indeed was Adam's work, having sorted out the surging life of the world of nature, and shown the relationship of animals who could have no knowledge of that relationship themselves.

Of course the real work of such a museum goes on behind the scenes, and the last time I was in the great basement galleries of the Department of Entomology, where a large part of that collection of eight million insect specimens is stored, there stood on a table in the room I was visiting a huge pile of cigar boxes, so that the place looked like a tobacco store. I asked what these were, and was told they contained a collection of specimens received that week, and that work was about to begin sorting them out. It is the same in every department. You can never walk through the Department of Botany without seeing someone sticking new specimens of pressed flowers or dried plants on to sheets of cardboard for reference and classification.

From all over the world specimens of every kind of living thing are constantly being supplied to the museum, and are being studied, and described in detail ; and in this way man's knowledge of the world of nature is growing day by day. Expeditions are sent to the wildest parts of the earth to collect specimens of creatures about which too little is known[1]; for, of course, it is not only in a museum that man

[1] As I was writing this chapter, I came across this paragraph in the newspaper :

" WOMAN'S YEAR IN WILDS TO COLLECT INSECTS FOR BRITISH MUSEUM.

" Sydney, *Wednesday, April 18th*, 1934.

" After a year of dangerous life in the wilds of Papua, Miss Lucy Evelyn Cheesman, the British entomologist, has arrived in Sydney safely with many specimens.

" Miss Cheesman was working in Papua on behalf of the British Museum, and has brought back with her 42,000 insect specimens, and various varieties of frogs and snakes collected during dangerous journeys in little known country.—*British United Press.*"

can come to understand the creatures of earth. To know all about the body-structure of a creature, and about his place among the other creatures, is not to know the whole secret of him. One can come close to his whole nature only when he is alive and living his natural life.

I learned this fact in a very simple way one night in the country when I was a boy. I had gone that day from London to stay with a country rector, and I was feeling very lonely and homesick, and after supper the rector, seeing how unhappy I looked, took me out into his garden. It was a moonless night, quite black. I was a London lad, not used to such complete darkness, and I stumbled behind the rector along a narrow winding pathway through a wood, until we came to a row of fair-sized boxes standing silent amid the trees. I could just make out their shapes as blacker bulks in the deep darkness.

"Bend down and put your ear to the side of this box," the rector said ; and I obeyed, and heard within the box a curious music I have ever since remembered, the music of a thousand tiny animals belonging to phylum Arthropoda, the music of the honey-bees going about their business in the city they had built within that box. For a year and more after that night my life was connected with that of the honey-bees ; for we might be suddenly called from our school-work to capture a swarm that hung like a ball of life upon a tree ; and there was often work to do for them, to make fresh frames for their honey-combs and reline their hives with warm felt and sacking when the cold of autumn set in. I speedily got used to what was at first a most alarming sight—the spectacle of the rector with hundreds of bees crawling over his hands and shoulders and climbing about the green veil that he wore over his face when working at the hives. I did, indeed, become quite used to the feel of the little feet over my hands, though now and then I was chased by a bee, and once or twice even suffered the indignity of being stung.

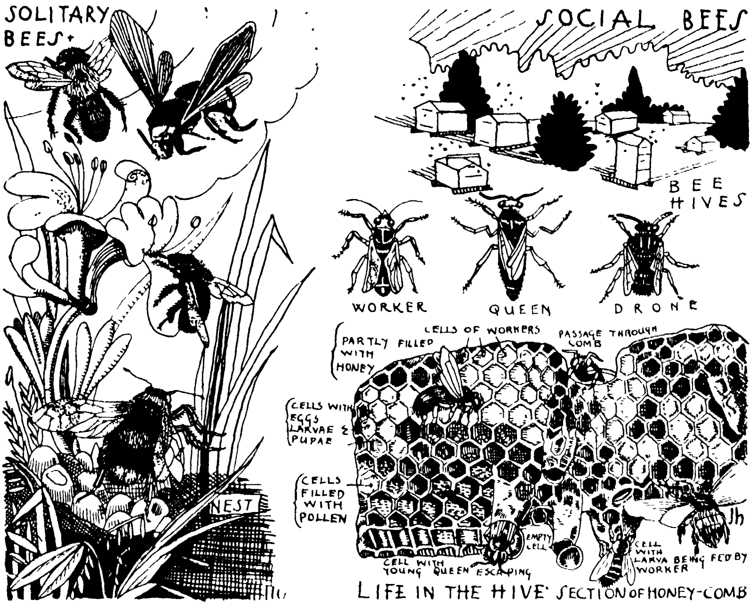
I really came to learn a good deal about the common domestic honey-bee (*Apis mellifera*) in the year and a half

during which I sojourned with that country rector; and these honey-bees stand, in organisation and intelligence, at the head of the whole class "Insecta."

There are more than 1,500 species of bee known to science, and the vast majority of these are "solitary"; that is, they do not live in hives, but each individual goes his and her own way. Even in the solitary species, however, there is some care of the young. Grown bees feed chiefly on nectar, but the larvae, as we have seen, are fed by their elders on "beebread," which consists of the pollen of flowers collected by the bees and made into small "loaves."

The bees begin their search for nectar and pollen with the opening of the first flowers in the spring, and do not cease until the withering of the last blossoms in the autumn compels the insects to hibernate.

In a hive there are three kinds of bees—workers, drones and queens: usually there is only one queen, who is a mother to the brood, but there may be two or three, or perhaps one queen and two or three "princesses" who are kept in case anything happens to the queen. For a bee hive depends entirely upon the queen. It is her family, and she is the mother to every bee in the hive. In the beginning she constructed a few cells and laid a few eggs in them, and out of those eggs came "worker" bees. Worker bees are actually "imperfect females"—that is, females who cannot lay eggs. Instead of being able to lay eggs the workers have other body aptitudes. Their mouth-parts grow out into a long "proboscis" for insertion into the nectar tubes of flowers, and from this mouth springs a long hairy tongue with a sort of ladle at the end, and this tongue laps up the nectar and brings it into a special bag or pouch within the abdomen where it ripens into honey: this honey is deposited in the hive by the worker, either as food for the community or for winter storage. The mouth of bees is also used for cutting and tearing off bits of leaves or the petals of flowers, which are taken home to the hive and used in the manufacture of "bee's wax," which is the building material for the construction of cells. In the




collection of pollen for the young the bees' jaws take no part. The pollen simply sticks on to their hairy backs, and they brush it into a special receptacle known as the *corbiculum* or " pollen basket."

In a hive of 50,000 bees there are about 30,000 field-workers, and each of these worker-bees makes an average of ten trips to the flowers each day, so that the bees of one hive pay 300,000 visits to flowers in a single day. A bee may visit as many as twenty or thirty flowers on each trip, though there are flowers which yield so much nectar so easily that a bee can get loaded up from a single blossom. About 37,000 bee-loads of nectar are required for one pound of honey.

The field-worker bees do not as a rule fly further than two miles from the hive. They depend greatly upon their large well-developed compound eyes for spying out the lie of the land and learning the shortest routes from the hive to the flower fields. Their usual method of flight is to rise

high in the air, flying in ever-widening circles until they catch sight of some landmark which they memorise. Then they will dart straight to their goal in the proverbial " bee line."

Bees possess a very high development of the nervous system, brain, and senses, all of which are fully called upon in the hard-working and varied life of the hive. Bees have acute vision of form and colour, a keen sense of smell and hearing, and they communicate with each other by means of their antennae.

The drone bees are the males, and they seem to correspond in hive life to the " unemployed " ; but it is not so much the trouble that there is no work for them to do as that they cannot or will not do any work. The workers, therefore, give them short shrift ; and at certain seasons all the drones are killed off by the worker bees.

The greater part of the life of a queen or mother bee is spent in laying eggs for the increase of the population of the hive, and the queen quite often lays as many as 3,000 eggs in a single day, all of which will be hatched and the young nursed and reared in the hive by the workers.

In order to understand the working of a bee hive more closely it would be as well to look at certain stages in the development towards hive life among insects in general. Let us first glance at the life of certain " solitary wasps." The wasps are first cousins to the bees, both families belonging to the order *Hymenoptera*, the order of the " joined-winged " insects.

Almost any insect with two pairs of semi-transparent wings, and a head and body of wasp-like or bee-like form, will generally be found to belong to the great insect order Hymenoptera, of which more than 30,000 species have been described, while probably more than ten times that number exist.

There are many species of solitary wasps, which scientists group under the name *Ammophila*, which means " the sand lovers " (though some species prefer mud, others soil).

These insects are very slender, long-legged black wasps, about an inch long, with an orange band around the abdomen just beyond the waist. The wings are much shorter than the abdomen and are smoke-coloured.

When a female Ammophila begins to feel the pressure of eggs ripening in her abdomen, instinct bids her dig a nest. For this purpose she chooses a spot in firm sand or hard soil, according to her species. We will watch the soil-lover at work. With her mandibles and front legs she digs a passage about an inch long, somewhat thinner than a lead pencil. This passage may slope down gently, or may drop down vertically like a well. At the bottom of the passage Ammophila hollows out a cave three quarters of an inch round. While she is digging she keeps carrying mouthfuls of earth away, flying a short distance and flinging the pellets of earth away with a toss of her head. If she piled a dump of earth close to her little burrow, all the world would know she had been at work there, and Ammophila is a secretive creature, and will take great pains to wipe out all traces of her work. The moment she has completed her hole and cave, Ammophila goes in search of a pebble or a hard lump of earth which will fit over the entrance and conceal it from view. She may bring up half a dozen small pebbles or pellets of earth before finding one that will fit. When at last she has closed up the entrance to her tiny nest, so that no creature could tell of its existence, her next job is to search for two caterpillars.

She prefers hairless green caterpillars and will sometimes spend days searching for them. When at length she sees one that will do, she flies upon its back, and curling the back part of her body, plunges her sting into her victim. Here we may pause to observe that the stings of wasps and bees and several other insects are forms assumed by the long prong that we saw at the back of mother daddy-longlegs. Stings are adaptations of this same instrument, which was evolved originally for the making of holes for the laying of eggs. The original and type-form of this part of insects' bodies is called the *ovipositor*, which means " egg-layer."

Of course the caterpillar does his best to resist this air-raid. He rolls his body up and jerks it out straight again like a broncho pony, but Ammophila in the rôle of Broncho Bill, rides the heaving little body until she has straddled herself across near the neck, when she opens her jaws and bites the nape of the caterpillar's neck. She stings her victim again and again, and the caterpillar is soon reduced to insensibility by the poison fluid from the sting. The wasp stings the silent caterpillar several times, so that it will remain paralysed for a week or more. After thoroughly flooring the caterpillar in this way, she may take a "breather," and polish herself up a bit before dragging the senseless creature all the way to the tiny burrow. The caterpillar is far too heavy for the wasp to fly with, like an eagle carrying off a sheep ; but Ammophila has the sense to turn it on its back so that its legs won't scrape along the ground as she hauls it off.

Ammophila brings her caterpillar to the mouth of the burrow and lays it down beside the entrance. Then she removes the pebble or pellet cover and seizing the caterpillar once more, she backs down into the burrow and disappears, with the caterpillar, out of sight. Soon she re-emerges again, blocks up the burrow and flies away to seek a second caterpillar. There follows a second battle, another long trek with the paralysed creature, and a second disappearance into the ground. This time the job is completed, and mother Ammophila has but one more task to perform. She lays her eggs in the burrow, attaching them with sticky stalks to the skins of the caterpillars ; and she then climbs out, blocks up the nest, and flies away.

Before she flies away, she may spend quite a time clearing up any mess she may have made outside the burrow—for she *does not* want any hunting insects or insect-hunting birds or other enemies to come along and disturb her brood. Mother Ammophila has been known to use a piece of stone as a hammer to flatten out the earth all over and around her nest. When she is perfectly satisfied that the sharpest detective in the world of nature could not tell there were precious

eggs in a cave an inch below the surface, she flies away and forgets all about her brood.

She flies away and forgets ; and for this reason she is classed among the solitary wasps ; but she has done her work well—very well ; and when within a week the eggs hatch and white maggot-like larvae appear in that tiny cave, they climb out of their eggs up the stalks on to the yet insensible caterpillars and eat their way through into the soft caterpillar bodies within. We see here why the mother wasp did not kill the caterpillars. Had she done so they would have gone bad in the week, but being only paralysed they remained alive and so their bodies were fresh and fit for eating by her babies. When the caterpillars are all but eaten the larvae are grown fine and strong and they spin themselves those silken, covered-in hammocks which we call cocoons, and inside these cocoons they will complete their change and growth into Ammophila wasps. If mother Ammophila made her nest in late summer or autumn the larvae may spend the winter in the cocoons, and emerge as the first Ammophila of next spring. By that time their mother will be dead, as will all wasps of that species who developed up to wing-stage before the winter. The cold kills them all off, and only those that dwell in cocoons in the caves under the ground survive the winter and carry on the wasp race the following year.

Now, there are other species of solitary wasps who remain until their eggs are hatched, and then tend and care for their young before they fly away and forget, and there are species who do not fly away at once, but soon bring forth another clutch of eggs, and the half-grown children will help her to rear them before they all scatter into the wide world. This is a form of life on the way towards hive life ; and finally there are hive-wasps, such as hornets, whose nests are only a little less well built and well organised than are those of honey-bees.

Let us have a look at these insect mothers who care for their young and so begin the evolution towards hives. The finest example of mother-love among insects is not to be

found in the vast order of " the joined-winged," but in the small order called Dermaptera, which means " the skin winged." This order includes the insects popularly called earwigs.

Contrary to general belief the earwig is not only an entirely harmless insect who does not bite, sting or commit personal injury of any kind ; he is actually accounted to be one of the insect friends of man, since he lives on many insects who are real pests, such as greenflies and scale insects, and also on slugs, snails and the eggs of moths and butterflies.

The mother earwig, like Ammophila, digs a short tunnel and a cave in which she deposits her eggs. There will be fifty or sixty pearly-hued eggs, and mother earwig never leaves them except when hunger drives her to seek food. Even then, she will not go far, and will perpetually run back to see if her eggs are safe.

She does not sit on her eggs like a bird, but sits beside them, guarding them with her jaws and first pair of legs, while the rest of her body, the second and third pairs of legs and her tail pincers guard the approach to the hole. For a fortnight or more she guards the eggs in this way, and reveals herself to be one of those fussy mothers with whom nothing is ever quite right. She is continually re-arranging her eggs, as if she thought they were not comfortable. Sometimes she digs a new hole and moves them all into it, because it is getting too damp and chilly or too dry and hot in the first hole. She can move ten or twelve eggs at a time, as they are sticky and cling together in lumps.

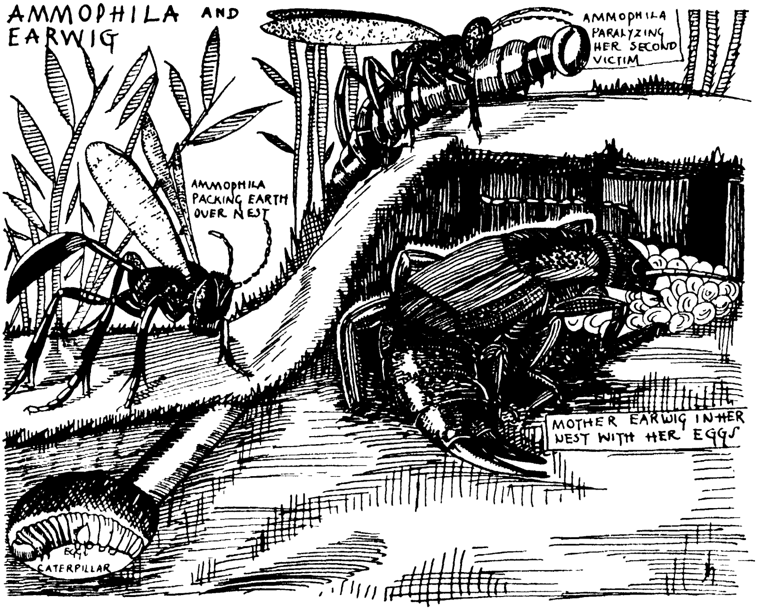
When her eggs begin to hatch out, mother earwig becomes frantically concerned, pushing her head and her feelers in among the eggs, aiding her young to emerge. The earwig family is not one that goes through the stages of metamorphosis, like the bees and wasps. The young that come from earwig eggs are tiny earwigs. An hour or so after the first earwig hatches out, mother is surrounded by fifty or sixty silver-white babies with jet black eyes, all swarming and crawling about her. Mother gets to work

digging out a bigger hole for them to run about in, and the babies get to work eating minute soil-bacteria and particles of decaying plants. In one hour after feeding, every silver-white baby has changed into an earth-brown earwig.

Mother earwig's work is not yet done. Like a hen with her chicks she leads her battalion of children about, directing them with her antennae with which she issues such short commands as "Attention! Left! Right! Halt!" For a further fortnight or so the grey-brown brood forage under mother's command, until they moult their skins and appear for the second time as bright silver-white insects (larger this time). In a very short space the whiteness has faded once more to brown earth colour.

Some time later they moult once more, again appearing white for a short space of time. Just before this third moult the wing cases of the earwigs appear, and after the moult the insect is in its perfect state, a "skin-winged" insect. Little good those wings are to the earwig. Not one earwig in a hundred thousand ever expands its wings throughout its life. Long ago in the history of the world, doubtless, the earlier earwigs flew; but they have given it up and now spend their whole time crawling about the soil and the plants.

The point of interest to us, however, is that long before the final moult comes, mother earwig will have dug another hole and laid a second clutch of eggs. Each mother earwig is able to rear three or four families each summer. These take two months to grow up, and she will press the half-grown members of her earlier families into the service of helping her with her later families, so that from time to time there is a regular crowd of more than 100 insects of different ages, sometimes nearly 200, all with one mother, all helping to guard and guide the younger members of the family. This is really the beginning of hive life; but, as they grow up, earwigs tend to scatter away to a solitary life, and many of the daughters will begin to raise families of their own. And then when the cold of autumn sets in, the thousands upon thousands who were born in the summer will




die of cold, because they have built no warm nest for themselves. Only a few who hide in warm crevices and remain in a dormant condition survive to start families again in the following spring.

A hive is simply a nest such as that of the solitary wasp Ammophila, or the earwig ; but instead of being one-caved, it is many-caved : instead of mother insect flying away and forgetting, she remains and constructs more caves for her next brood of children ; and instead of the children flying away and forgetting, they remain to help mother with the younger children ; and with all these helpers aiding her, the mother insect gives up every other interest in life save that of laying eggs and ruling her brood. So she becomes the queen of a hive.

We can see the hive in its full splendour if we turn back to the great order Hymenoptera, " the joined-winged," the order of the bees and wasps, and observe another great family group within this order, that of the ants. Actually, the

ants are not nearly so high in the scale of evolution as are the bees and wasps : they are quite low in the scale of hymenopterous insects ; yet certain species of them have perfected hive life to an even finer degree than have the honey-bees.

Ants inhabit all parts of all continents of the world, and there are usually more ants in any one place than there are of any other kind of insect. Worker ants are known to live from four to seven years, queens from thirteen to fifteen years, and their colonies are said sometimes to outlast a generation of men. The multiplication of their numbers and their survival during a number of years is due not only to the protection which their nests give them and the marvellous organisation of life which has come about within those nests. They are also helped by the fact that they build their underground cities of bare earth, instead of such stuff as wax, which the bees make out of flower petals and other seasonal and fragile things. The bees " overdo " certain things : they work too hard and die young. It is rare for a worker bee to live for a whole summer. Usually a worker is worn out and dies in a few months, whilst queen bees are lucky if they see three summers. The ants have learned to avoid many of the mistakes of bees, though if, as King Solomon said, there are lessons which even we men can learn from ants, some of those lessons are warnings not to do as the ants do.

A colony of ants begins in just the same way as a family of Ammophila wasps or of earwigs. The mother ant, feeling the eggs within her, burrows out a cave and lays her eggs. The first brood that hatches consists of winged males and females and of worker ants, who have no wings. The ant mother begins like mother earwig, feeding and aiding the helpless little grubs. When they are grown up, they turn and begin to feed and help her, and mother ant from henceforth is a queen whose sole duty is the laying of eggs.

When the young grubs reach their full size they change to the chrysalis state, spinning little cocoons in which they

remain for about ninety days, when they emerge as fully-grown ants, ready for work. When they come out of their cocoons they are covered with a thin skin, like a little shirt; and their first duty is to help each other take off these little shirts.

Then to serious work. Mother is laying more eggs. Caves must be dug for them, and living-rooms for the grown-up children. Chambers and galleries, storerooms and defence works, have to be built, for the ant-family knows that hundreds of their kind, thousands of their kind, are coming to join them, and a whole underground city must be dug out, and all the needs of life for all these creatures must be arranged for.

In a large cave, from which she never comes out, lies the queen ant. Special workers act as her servants, bringing her food and placing it in her mouth, for she has lost the power of feeding herself. These servants have to attend to the queen's toilet and keep her cave clean.

The ants are very careful of the cleanliness of their nest. All refuse, such as old cocoons, scraps of food and dead ants are carried to dumps outside the nest. The ants also spend much time cleaning themselves. Their short tongues are rough, and are used much like cats' tongues. Ants not only clean themselves in this fashion, but help each other to keep clean, and they clean the larvae and eggs.

The eggs, of course, are the beginning of the whole life of the ant city, and a constant stream of workers is for ever carrying them away from the queen's chamber to the *hatchery*. When the young come forth from the eggs they cannot feed themselves, as can the young of other insects. They are fed by nurse-workers who digest the food for them and place it in their mouths, in the same way that pigeons feed their young.

Like human children, the little ants need fresh air, so nurses carry them round the galleries of the city. The young in cocoons, though they need no feeding, have to be very carefully watched, to see that their cave does not become

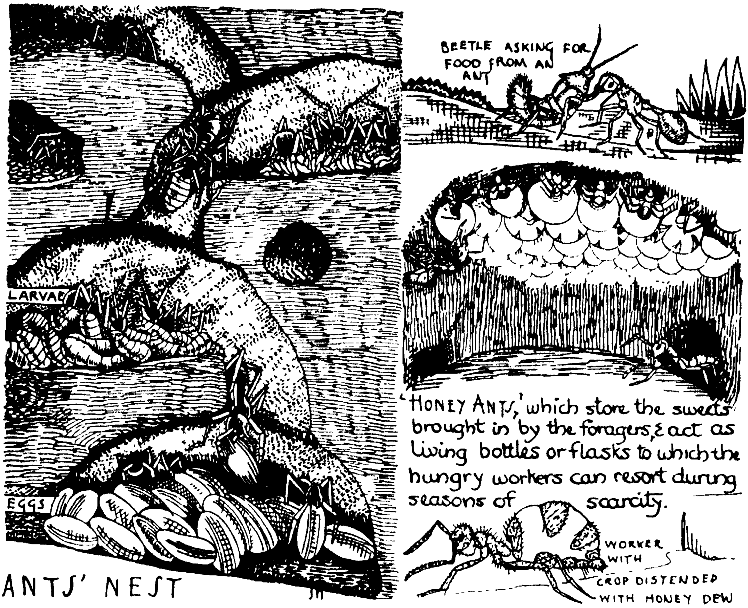
too damp and cold, or too hot and dry ; and often enough the cocoons are moved to fresh quarters.

When the cocoons split and the fully formed ants appear, nurses help them out of their skin shirts, and rub them down.

While this activity is constantly going on inside the nest, there is a stream of workers engaged on outside jobs—workers foraging for food and other material needs of the nest, and bringing it in from the vast outer world. Some species of ant gather seeds of grasses and weeds and store them in great granaries in the nest for their winter food. Others cut off leaves, carry them to galleries in the nest and shred them to form a green manure, on which they scatter the minute spores of certain fungi. The fungi grow only on this manure and the ants make this fungus their food. Thus we see that ants are gardeners !

There are also ants who keep a certain species of plant-bug for the sweet " milk " which they produce, in the same way as men keep cows. These insects are themselves very interesting and carry on their species by a sort of alternation of generations not unlike that of the ferns and other creatures at which we looked earlier in this book. There are among these plant-bugs ordinary winged males and females, but during the summer there hatches out of their eggs a generation without wings, who live by sticking their proboscis into the soft tissues of the plants on which they were born, to suck up the plant juices. They remain thus stuck there and, as it were, grow on the plant ; for although they have long legs they do not move unless they are compelled to do so ; and when they have planted themselves there a sort of bud grows out of this rooted fly and this bud turns out to be a small edition of its parent : then other and other buds swell up and break off as little wingless flies, until a plant may be covered with a multitude of these insects all clinging by their probosces and sucking the plant juices. Sometimes they become a serious pest, weakening or even destroying plants by sucking them dry.

When the cold of autumn strikes down, or when the plant




on which this budded-off family is feeding begins to run dry and wither, male and female flies with wings are produced and these fly off to seek a better plant on which to live. The females lay their eggs on a rich and healthy plant (after surviving the winter perhaps in some crevice of tree bark or old house) and from these eggs the wingless sucking generation comes forth once again.

The scientific name for these insects is *Aphides*, singular *Aphis* : they belong to the order *Hemiptera* and are sometimes called greenfly.

Among the points of interest in the anatomy of the aphides is the fact that they have two little tubes that stick out over their backs, and from these tubes they pour a sweet syrupy liquid which we call " honey dew." This seems to be the surplus of the juices which they suck from the plant, changed and enriched in some manner.

Ants are very fond of this honey dew, and so they never harm aphides. Indeed, so far from harming them, some

species of ants carry the wingless sucking aphides in their jaws to the nest, where they are taken off at once, to chambers prepared for them. As many as 1,000 aphides have been found in a single ants' nest.

We have no further space in which to describe the life of an ant city. We have said nothing about the soldier ants, and the battles that are fought between rival nests, nor have we shown how some species of ant live upon the work of ants they have captured from rival nests, whom they make slave-ants. Nor have we told of the more marvellous of their engineering achievements, such as the way in which they sometimes dig wells down through the earth to underground water for the supply of the colony.

The insects which have developed the hive or nest life to the most marvellous degree of all are those called termites or "white ants." Actually, these insects are not always white, but earth-coloured, and they are not ants, but belong to another order, called Isoptera. The termites are a tropical order, and do not come within the scope of this book.

## CHAPTER IV

# "THE SCALE-WINGED"

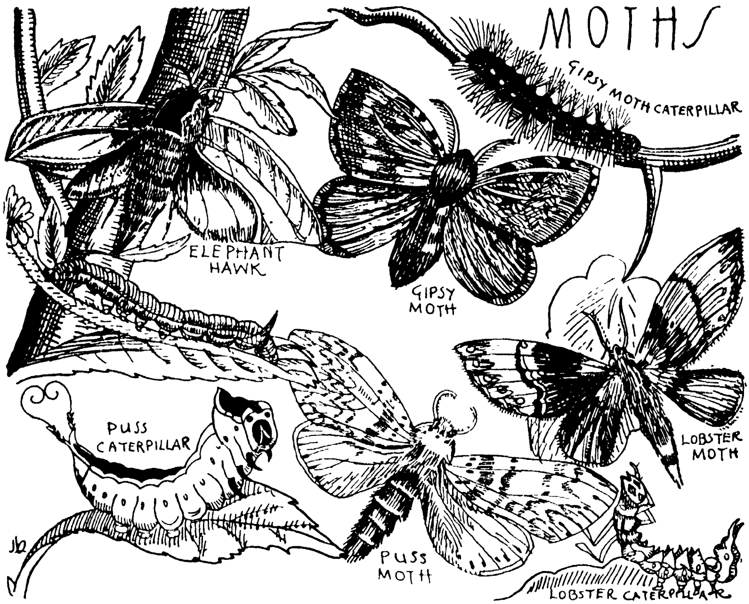
ANIMALS who *never eat or drink* !—you would not think there were many of *them* in the world of nature ; but there are—whole species of them, who have no mouths and no stomachs, because they have no need of food and drink. You find them especially among the moths and butterflies. The tent moth, for instance, has neither mouth nor stomach; and never a scrap of food nor a drop of drink passes into him from the day he is born until he dies. . . .

Perhaps that is not a fair way to put things, for, as everyone knows, moths and butterflies come from caterpillars, and caterpillars spend their entire existence eating. Consider the gypsy moth caterpillars whose ambition it is, as we saw in Chapter One, to eat all the leaves off all the trees in North America. Never imagine it is the gypsy *moth* who is the cause of all the trouble : it is the gypsy moth *caterpillar* who tries to put the whole world of green leaves inside him. It is always the caterpillar, not the moth, who is the trouble. It is not the clothes moth who destroys our silk and woollen fabrics, but his caterpillar.

Those moths and butterflies who do take food, sip it from the flowers in the form of nectar, and are therefore useful creatures and in no sense harmful to any living thing.

They cross-pollinate the flowers and help to beautify and enrich the earth. Moths and butterflies, however, perform one rather sinister act. They lay eggs which in course of time will hatch out into caterpillars. . . .

Though moths and butterflies may not eat, or may live by sipping the sweet nectar of flowers, they do not forget




that their caterpillar young will possess powerful biting jaws and will need a vast supply of green leaves. Therefore with unerring instinct moth and butterfly mothers will lay their eggs on the plants which provide the best food-leaves for their caterpillar young.

Most moths and butterflies fasten their eggs, with the help of a natural gum, on to the leaves or stalks of the caterpillar food-plant. The " large white " butterfly lays her beautifully iridescent whitish-yellow eggs (they look like miniature pieces of porcelain exquisitely graved with the finest designs) upon the leaves of cabbages, which the caterpillars will relish and will eat away, to the despair of the kitchen gardener. The gorgeous " swallow tail " butterflies, whose wings are most curiously shaped and end in two little points—most lovely wings of bright yellow, artistically contrasted with edgings and veinings of velvety black, relieved here and there by spots of silver-blue and orange-red—lay their eggs upon the stems and leaves of wild carrot,

marsh parsley and several other kinds of plants whose leaves will form the food of the hungry young caterpillars when they hatch out.

But there are probably about 100,000 species of moths and butterflies in the world. Round about 2,000 species are native to Britain. Of course there is a great variety in the habits of these thousands of kinds of insects. Many kinds lay their eggs in wood. The "goat moth," for instance, lays her eggs—100 and more—in crevices in the bark of a tree. When the caterpillars emerge from the eggs they at once bore their way into the wood, where they live for about three years chewing the wood. The caterpillars of the "common blue" butterfly live by eating certain grasses, and instead of laying her eggs upon those grasses, the butterfly scatters her eggs helter-skelter among the grass.

A caterpillar is a remarkable animal. He is as unlike a moth or a butterfly as a crocodile is unlike a swan. Yet he is a child-moth or child-butterfly. As one modern writer has aptly put it, caterpillars have carried the "independence of youth" to the furthest possible extreme. No one would know them for the children of their parents, unless he had studied the marvel of insect metamorphosis.

As a general rule the caterpillars of butterflies and moths have thirteen rings or segments, which, together with the head, make up fourteen parts. The first three of these rings bear each a pair of legs, called the *true legs*, because these are the legs which are going to turn into the legs of the adult butterfly or moth. The head bears two frail antennae, two imperfectly formed eyes, and that most useful of all appendages, a good strong pair of jaws.

Rings 6, 7, 8 and 9 bear each a pair of circular discs which in most species are fringed all over with delicate hooks, by means of which the caterpillars cling on to the branches and stems and leaves of the plants on which they feed. These discs are called "false legs" or "pro-legs"; and in nearly all caterpillars there is a final pair of "false legs" on the last ring of all. These hooked discs enable the caterpillars to cling so tightly that often they cannot be

pulled away from the plant without hurt. The caterpillars can, however, very speedily release themselves and fall to the ground if they wish. The caterpillars of the " common blue " butterfly will drop off the blades of grass the moment there is any hint of the approach of sheep or cow. Everybody has probably met with the " woolly bear " caterpillar of the tiger moth, and touched its long silky hairs. Even if only one or two of its hairs are touched very gently, the caterpillar releases its hold on its food plant and will probably coil up and fall to the ground.

Although caterpillars are almost blind, having tiny half-formed eyes, very different from the large and lovely compound eyes of adult butterflies and moths, these curious wormy sixteen-legged creatures are fairly well protected against a world of foes.

A world of foes, did I say? Remember the fact that in their native lands ninety out of every hundred gypsy moths will be killed off by their enemies! Some may be killed whilst they are moths, but most of them will be killed when in the caterpillar stage. Countless are the enemies of the caterpillars. These enemies range from birds who will come hopping gaily along, popping a dozen or so caterpillars into their gizzards in as many minutes, to all sorts of insects, who will attack caterpillars in many astonishing ways. No enemies of the caterpillars are more deadly than certain species of flies.

The fly group boasts more than 50,000 species, and forms the order *Diptera* which means " two-winged." If we may borrow an aeronautical term we may say that the flies are monoplane insects. The general form of the insect body includes two pairs of wings. Insects are by nature biplanes; but in many species the second pair of wings is shrunk almost to nothingness, and this is the case with the flies. All that remains of the seond pair of wings in flies are two tiny stalked organs of drum-stick shape, known as the balancers. These are not without their use, since when they are removed the insect is no longer able to balance himself in the air, so that these remnants of the second pair of wings are

thought to have the same sort of use as the fins of fishes. We will look at the splendid double wings of the butterflies and moths when we have followed the struggles of the caterpillar through his chrysalis stage to the perfect state. We have yet to encounter the enemies that lie in wait for him, and watch some of the deadly battles that are fought on the green foliage of the trees in the summer sunshine.

No true two-winged fly has a biting mouth, or a sting tail. Instead, flies have sucking proboscces, as have the moths and butterflies. In some species of flies these proboscces are provided with miniature swords to pierce the skin of creatures so that they may suck blood. Gnats are members of the fly order who are so armed. At the other end of flies, as we have seen, is often a sharp-pointed tail. This tail is used solely to aid in egg-laying, as we saw in the case of the cranefly, or daddy longlegs. In certain flies this sharp tail-piece is the most deadly weapon of all.

All caterpillars have evolved some form of protection against foes. If it is not a weapon, it may be a "mask," like that of the "elephant hawk" moth : this caterpillar has a pair of large eyes marked upon his front, giving him the appearance of a reptile. Actually his eyes, like that of all caterpillars, are almost invisibly small.

The caterpillar of the lobster moth is about the weirdest looking creature one could ever come across. This caterpillar usually feeds upon beech-leaves, and has a body which resembles that of a lobster—hence the name. Unlike any other caterpillar he has very long front legs, like a spider's. "When he is at rest on a beech twig he tucks up these long legs so that they become invisible, and the caterpillar then strongly resembles the brown, cast-off leaf-sheaths that one sees on beeches." This likeness to dead portions of beeches is a protection to the caterpillar, who will not be so easily observed by his enemies. If an enemy should appear on the scene, out go his legs at once, and his appearance changes, as if by the touch of a magic wand, to that of a particularly evil-looking spider, to the great discomfort of the enemy.

For what fly dare blunder too close to that hereditary enemy of the flies ?

The spider and the fly ! It's a cunning trick of the caterpillar to play the one off against the other ; but the most cunning of all caterpillar tricks is their ability to make themselves look like their surroundings : "*protective mimicry*," as it is called.

The most marvellous example of protective mimicry among caterpillars is that of the caterpillars of the thorn moths (there are several species, adapted in appearance to the twigs of different trees). The "September thorn" caterpillar, for example, feeds chiefly on oak leaves, and the body of this caterpillar is of the same brown tint as the twigs, and is mottled and marbled and adorned with little humps in imitation of the spots and grains and little notches that are to be found on oak twigs. The head of this caterpillar is an excellent imitation of an oak leaf-bud, and when the creature is at rest, it sticks its body up from a twig until it so closely resembles a branch twig that it is certain to have deceived you if you have often lain out under oak-trees and gazed up at their branches around you.

All these devices do not save myriads of caterpillars from the beaks of birds, and from countless other enemies among the insects, mammals and reptiles ; yet not all caterpillars are entirely on the defensive against this world of foes. There is the case of the caterpillar of the puss moth.

This caterpillar can squirt a fine poison spray at his enemies ; and this will result in a life-and-death struggle between caterpillar and ichneumon ; for, once the fly gets the force of the poison stream he will collapse and probably die. This poison is far more deadly than that in the stings of bees and wasps, and will take the skin off your face if you receive any. The puss moth has a most ugly and fierce mask which probably serves to hold the horrified attention of his enemies while the caterpillar squirts out his spray at the fly.

We may pause to remind ourselves that these most fierce and deadly battles under the greenwood trees are all a part of that "balance of nature" to which we have several

times referred. If the caterpillars had no enemies they would speedily strip all the earth of its greenery and all living things would in consequence die.

Those caterpillars which survive next enter upon the chrysalis stage, which, as we saw in Chapter II, is the period when the caterpillar body is broken up and re-built on a different plan. During such a marvellous change the creature can of course not lead an active life ; and so it spins itself a cocoon in which to lie quiet and protected during the change. Out of certain glands in the bodies of caterpillars a thread-like stuff unrolls, and this is worked back and forth, as weavers' work, to form a covering completely enclosing the caterpillar. The "silk-worms" are the caterpillars of the mulberry silk moth, whose threads are the only source of supply of real silk. There are several species. The cultivation of this caterpillar began in China probably at least three thousand years before Christ, and the history of the cultivation is interwoven with the whole history of man. The fine silks of kings and queens and noblemen from the earliest ages have been made from the cocoons of this caterpillar. The prosperity of many cities, even of whole states, has been built upon the cultivation of the silkworm. It is now cultivated in all parts of the world.

It is a quaint thought that the planting of orchards of fruit trees solely in order that the leaves should be eaten by caterpillars has been undertaken from the earliest times. It is the reverse of the gypsy moth campaign in North America ! The only way of cultivating silk moth caterpillars is to plant orchards of mulberry-trees for them to feed upon. The eggs of the silk moth are artificially hatched in incubators at the time when the mulberry leaves are unfolding in the spring, and the caterpillars are released on the trees to eat until cocoon time. The cocoons are made of the raw silk, which is reeled off by men.

The cocoons of other caterpillars are of no use to any creature except the caterpillars ; and in the cocoons they lie up snugly while they are re-made into moths and butterflies. In this state they are called *chrysalids* (singular,

*chrysalis*), the scientific name for a chrysalis being *pupa*. There is a scientific verb *to pupate*, to describe the change from caterpillar within the cocoon.

The chrysalids remain, each in his cocoon, throughout the winter, swinging in the frail closed-in hammocks of soft silky material whilst tempests rage and frosts bite down through the ground. Here these helpless insects have also to face their living enemies, the birds and other creatures who are only too anxious to tear open the frail covering and devour the living chrysalis within. For this reason many cocoons adopt protective mimicry. Some are green-coloured and leaf-shaped, and can hardly be distinguished from the leaves upon which the caterpillar has for so long fed. Others resemble the bark of the tree on which they are stuck. And they are not all frail silk-like hammocks. Some are made of a mixture of wood chewed up by the caterpillar and threaded into a sort of wooden box. Others are as hard as concrete fortresses, made of a sort of cement which hardens about the chrysalis ; out of some of these solid cocoons the developed moths and butterflies can escape only with the aid of an acid chemical substance they possess, which oozes out and eats a passage through the concrete.

Even so, a huge toll is taken of the chrysalids during the long winter in the north temperate zone ; and the moths and butterflies that come out into the world of blue sky and gold sunshine and green plants, the moths and butterflies that flutter their way amid the glowing colours of the garden flowers, are the survivors, the few remaining heroes, who have fought their way through caterpillar life and have lain in peril in cocoons.

Getting out of the cocoon is no easy matter. Once upon a time in the days of Ancient Rome the statues on the Appian Way were found to be " sweating with blood," a fact which much excited the superstitious pagans of the Imperial City.[1] They never thought of assigning a *natural*

[1] The story of the statues on the Appian Way is told by the old historian Livy, who was born 59 B.C. and died A.D. 17.

cause to such an occurrence, and took it to be an omen and sign of things to come.

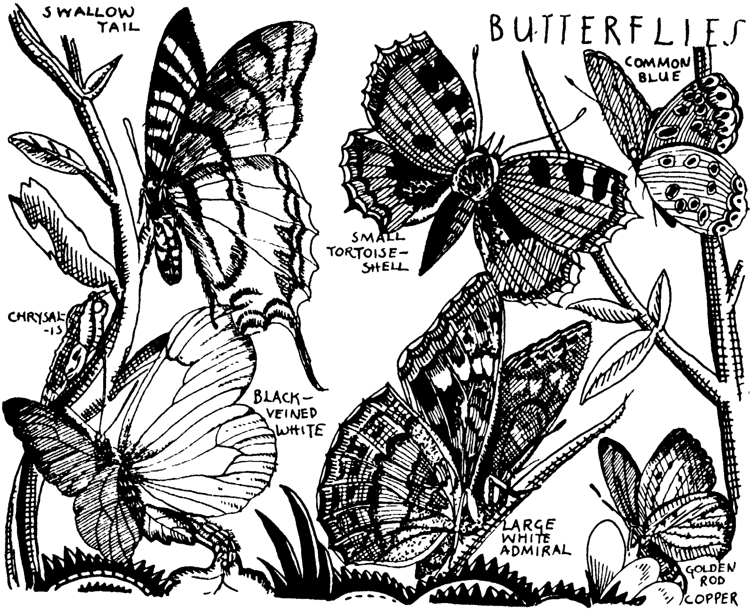
As a matter of fact, when moths and butterflies struggle out of their cocoons, a drop of liquid also comes forth from them. The liquid coming from some species—such as the "small tortoiseshell" butterfly—is of a bright red colour, and is very like blood. "It is quite reasonable to suppose that in the immediate vicinity of the statues there might have been some large clumps of nettles, and these would naturally enough have been chosen as a breeding place by the small tortoiseshell butterfly, who feeds exclusively on nettles, or by any of his kindred species who feed on the same plant. The perfect insects on emerging would at once crawl up the first convenient wall or tree as a resting place while their wings were expanding, and would be quite as likely as not to choose for this purpose the precious statues, as being near and handy for them. There they would sit until their wings were dried, and each would then deposit his little drop of red fluid before taking flight, thereby becoming the innocent cause of much dismay among the people, who immediately proclaimed days of supplication and vowed all sorts of offerings to their gods."

From the tiny prison-tent or prison-cell of the cocoon has emerged a wondrous winged insect. "Jean Paul" Richter[1] called the butterflies "the flowers of the air," likening their gorgeous-coloured patterns and exquisitely shaped bodies and wings to living flower petals that have the power of flight.

The beauty of a butterfly's wings is based upon the form and colour of the scales with which they are covered, as with a kind of mosaic. Dust-like as they appear to the naked eye, the scales of a butterfly's wings are seen under the microscope to resemble minute coloured bags arranged in rows. Actually these scales are formed of chitin. These scales are fitted in their hundreds upon the four wings that spring from the insect's body.

It is an exquisite thing to see a moth or butterfly emerge

[1] The famous German author (1763–1825).




from a chrysalis. Out of a small dead-looking growth on a tree-trunk or a branch struggles forth a crumpled damp-looking colourless insect, which crawls painfully quivering up to a place where he can securely stand. Then in a few moments a change comes. The wings grow before your eyes (they really expand their thousand folds and creases). Colours most vivid and glittering appear upon the drab creature (revealed really from their hiding places in the crumples of the unexpanded wings, yet actually gaining their full strength and brightness from their first contact with the sun). Long legs are stretched, long delicate antennae wave in the air, the antennae of some species being feathered delicately, in others nobly curled, and yet in others tipped with jewel-knobs of colour. Between the legs and wings and antennae lies a shining or a softly furred body, a velvet form or a glittering scaly figure. Upon the perfect insect's head glow the perfect compound eyes.

Then the wings flutter. The creature quivers for an instant—and goes up into the air, fluttering in the sun.

Yet even in the air, a butterfly's life is not all pleasure, and thousands of times every summer, a new-born butterfly has met with a swallow. A swift bird-form swishes through the air. Hey presto ! the flash of coloured wings is gone for ever. Or the butterfly may hover for an instant one inch too close to the surface of a stream. Snap ! a fish, a trout, perhaps, or pike, or maybe our wandering friend the eel, has got him. The wary moths come forth in many cases only at night, or at dusk. Even then, owls and bats and many foragers of the darkness may engulf the new-born moth the moment after his arrival in the world. . . .

Among moths and butterflies, as among their caterpillars, protective colouring is one of the chief safeguards of their lives. You may have been watching a glittering "purple emperor" butterfly one day, and suddenly he will seem to disappear. He has but lifted his four wings above him and pressed them together. The under sides of the wings are not nearly so gaily coloured as the upper sides. In fact, they are protectively coloured to blend with the surroundings, and when the butterfly closes his wings above him in this way it is almost impossible to find him in his natural habitat. Moths close their wings differently from butterflies. They usually fold them against the body more after the fashion of birds. This, indeed, is one of the few differences there are between moths and butterflies. Another general rule is that moths are in the habit of laying huge masses of eggs, sometimes more than 100, in a lump together, whilst butterflies are apt to lay but two or three together in one place, and two or three more elsewhere, and so on. Apart from a few such peculiarities, there is not much to distinguish between them.

## CHAPTER V

# MORE TERRIBLE THAN THE LION

WE HAVE SEEN something of the struggle for life that goes on upon the green foliage leaves in our back garden, in the common hedgerows around us. We have not been able, of course, to view the world-wide battle-line of the life-long insect war ; and there are thousands of insect forms which swarm under our noses every day that we must omit from this general survey of the world of nature.

We can devote no space to the fascinating tale of men's insect allies nor tell how man has enlisted the ladybird beetles, the hover flies, the lacewing flies, and many more, to eat up the aphides that destroy our own food plants and infest our fruit and grain crops. Man lets loose his battalions of beetles and flies upon his crops to destroy the pests. It is surely the strangest campaign in history.

I hope, however, that we have looked at enough to enable us to realise how great is the conflict ; and perhaps if we glance—we can do no more—at one further aspect of the insect war, our imagination may be drawn to view the further vistas of the fight. In this further aspect the insects are but carriers of beings even more harmful to man.

Great tragedies of human history have been caused through the agency of these insects. For instance, in the seventeenth century nearly one quarter of the population of London was killed by plague. In 1720 Marseilles lost half its population, and during a couple of hundred years deaths from the same cause in France, Germany and Italy ran into tens of millions of people. This plague was a

germ or bacteria which was carried by a flea that was carried by a rat.

Some insects, as we have seen, are fond of sucking blood. We instanced gnats. The flea is another of these creatures ; and it is while the flea's proboscis is stuck into the victim's skin that the one-celled bacteria swims into the human body, where it feeds upon human beings, divides and multiplies there, and overthrows the whole organisation of the body.

We looked briefly in Chapter III, Book One, at the blood of man and we saw the red blood corpuscles at work like tramp ships carrying food and oxygen to every cell in the body. These corpuscles, we saw, were one-celled beings, like amoebae. There are actually two sorts of one-celled creatures in the blood. Beside the red cells of the corpuscles there are white cells, and these white cells are like soldiers. They fight to protect the red blood corpuscles and keep the whole body healthy. What creature is better fitted to fight a bacteria than is a white soldier-cell in the blood of man ?

For remember that bacteria are one-celled beings. They are pirate protozoa, rebels who live by destroying. They will not organise. They will not become decent citizens of a myriad-celled body ; but like bandits they are out to rob and kill.

A doctor has said that the laws of disease are as beautiful as the laws of health ; and to give the bacteria their due they are as finely developed and as beautifully adapted to *their* way of life as the myriad cells in the organs of a human body are adapted to *theirs*. Bacteria are the smallest and simplest creatures known, far smaller and much simpler than amoebae and diatoms. No bacteria is large enough to be seen by the naked eye. Like all the Protozoa, they grow in numbers by dividing in half, the two halves growing into two bacteria. They live everywhere where other creatures live—on land, in water, on the dust, in the air—and in some places where no other creature has ever been found, such as in subterranean oil pools hundreds of feet below the ground. Some must have oxygen, some can

live only where there is no oxygen, some eat iron, sulphur and other minerals.

Their incredible smallness enables them to be practically ubiquitous—that is, to live everywhere. They can squeeze in through the molecules where it would be utterly impossible for any other live thing to think of going. We have seen that the soil swarms with them, and there we learned that they are not all evil in their ways. Indeed, they are the ultimate housebreakers and scavengers, without whose work the elements themselves would get caught up and imprisoned so that life on earth would stop. But that does not prevent large numbers of them being the worst of all parasites and pests, parasites and pests that deal death and disease to human beings, by swarming into us, upsetting the glorious flow of our blood and the regular and healthy functioning of our organs.

They may get into us by many means, the agency of the blood-sucking insects being one of them. The actual cause of malaria is a one-celled blood parasite which destroys the red blood corpuscles. Only through the " bite "[1] of a mosquito can a man be infected with malaria. We all know to-day the story of the cutting of the Panama Canal, and how the work was held up for scores of years, many hundreds of men being killed by malaria ; and only when men found out that mosquitoes carried the malaria germ was there any hope of completing the canal. It was a long search to find the right mosquito. There are at least 1,500 species of mosquito in the world, and only seven or eight kinds grouped now into a genus called *Anopheles*, can carry the malaria parasite ; but the germ-carrying mosquito was found at last, and malaria was banished from Panama by destroying the breeding-places of the *Anopheles*.

From this story we learn that although the bacteria may swarm in countless myriads of myriads all over the earth, each species of them may be able to live only in very few places and in very special ways, and this fact alone gives us hope and guidance in our struggle against bacterial

[1] We popularly say " bite," but " suck " is really the right word.

disease. A large part of research work in medicine is simply field-work in natural history, the study of the life-habits of animals which are invisible, whose very existence is known often only because of the damage they do.

In our daily life it is well to be armed with knowledge about the ways of the bacteria that ride upon insects. The common house-fly can get our body into trouble, and fleas and lice, as all nice people know, are creatures to be avoided. The far-back ancestors of the fleas were winged insects that lived in the open, and every living flea carries a relic of these bygone types in tiny useless remnants of wings packed away beneath a scale on his back. Naturalists place them in a class named *Aphaniptera*, which is Greek and means " wingless." Like the flies, and the moths and butterflies, and so many other insects, fleas have three stages in their development—egg—grub—chrysalis. Fleas do not bite. They have no mouths, but they have swords and suckers. Once upon a time no doubt their free-flying ancestors sucked nectar, like the harmless bees and butterflies ; but one flea one day tasted blood, and since that day they have preferred blood, like a lion or a tiger who has once tasted blood. And the flea may be more terrible than the lion.

In this further stage of life's warfare we see that the jungle ways invade our own homes, and the battles beneath the green trees are carried into our own flesh, to lurk in us nearer than hands and feet. In great wars between nations, where men try to kill each other, a rearguard action is being all the time fought in the field-hospitals, where the wounded men are sought to be saved. In precisely the same way the bacteria war is being fought to-day in hospitals throughout the world.

With this, then, we must draw to the close of our all-too-brief survey of the fantastic world of insect life. Innumerable are the fascinating and innocent forms which we must perforce leave out ; but the insect world is such a wonderful world that no one who has begun to study it could sit in a field or by a pond, and not begin to open his eyes and

watch keenly for examples of this the largest of all classes of living beings.

Let us therefore finally go forth to visit a stream or pool which may prove even more wonderful than the sea-pool we visited in the early chapters of this book.

# CHAPTER VI

# THE AQUATIC INSECTS

LIFE BEGINS, we may say, where the springs well out of the hillside ; because all life depends upon water.[1] The perpetual motion of the waters, from the sea to the land and to the sea again, is like the cycle of living forms, from birth to death and from death to living forms once more.[2]

The wheel of the waters and the wheel of life roll side by side throughout the ages of the earth, ever turning yet never returning, for there is nothing old under the sun : death sweeps away the old to make room for the new, and time makes possible changes even in dead things. So, forms change, from age to age ; and in the story of evolution has been traced the rise of higher forms from lower.

As a poet has said, " springs rise not above their source " ; and what we call higher forms are more powerful and suitable forms, forms better adapted, that is, to life in the environments in which they find themselves. New possibilities arise with new contacts and new combinations, and the living spirits within the forms of creatures can generally, in the end, be trusted to take advantage of every opportunity for advance, and to evolve the means whereby the environment may be made a home.

And so, from the hub of things, from the ultimate content of the universe, where all that is possible has its source, have arisen on our planet the phyla of living beings, the

[1] See section called " Environment and Life " ; also illustration, "The Round of the Waters," on p. 128.

[2] See Book Two, Chapter I.

orders and classes and families, the genera and species, and the minutely changing myriads of individuals. Each kind of creature, each way of life, is determined as much by the environment as by the inmost nature of the creature ; and nowhere do we find so many forms and ways of life as we do in the waters or by the water-side. We saw, in Book One, something of the variety of life in the salt coastal waters. The inland waters are scarcely less full of teeming life.

Where water flows abundantly over the land, there will life be lush and varied : where water is scarce, there life will be rare and mean.

Stand with me beside the source of a great river, and watch the airless welling of the original spring. Here it is high land, with hills around, and marshes, and few trees : the vegetation by the spring is scanty—moss and lichen on the stones, the hardier sorts of grasses growing around. There seems to be no life in the crystal-clear spring water.

But lift a stone from the water's edge, and you will see some little animal scud hastily across to find a new retreat. Carefully pluck a handful of the moss and shake it under water, and a whole company of small animals will reveal themselves. Small snails, and copepods, and caddis worms (the *larvae* of caddis flies), little blood-sucking water mites that cling by hooked claws to the moss, waiting to fix themselves upon the bodies of its more peaceful tenants ; these are but a few of the moss dwellers and stone shelterers.

Out in the little eddies and currents of the spring-pool and the young stream, we find curious minute creatures who cling to the stones not so much by their own power as by that of surface-tension—the law that keeps a film of water clinging stationary to a stone, no matter how swiftly the current may be flowing all round. One of these creatures is the worm-like larva of a midge fly. Such creatures will be found in the thin line of stationary water along the banks and boulders of every brook.

These first creatures to be found in the headstream of a brook are representative of a population that reaches vast proportions as the stream widens out into a river ; but as a

stream widens and deepens, so new forms of life add themselves and many of the old forms disappear. Like the seaside beach, the reaches of a river have their zones of life, which are generally divided into (a) *the headstreams*, (b) *the trout-beck*, (c) *the minnow reaches*, and (d) *the lowland courses.*

The creatures of the world of nature take no account of man's scientific divisions, and in no stream can we stop at a point on the bank and say, " This is where the headstream and the trout-beck meet." The trout-beck is confined to the favourite reaches of *Salmo fario*, the trout ; but often (as at the source of the Pang in Berkshire) the biggest trout can be found basking in the fresh spring waters at the very start of the headstream. We will not, therefore, attempt to examine each river-zone in turn, but will wander along the bank of a typical stream and river examining what we may find.

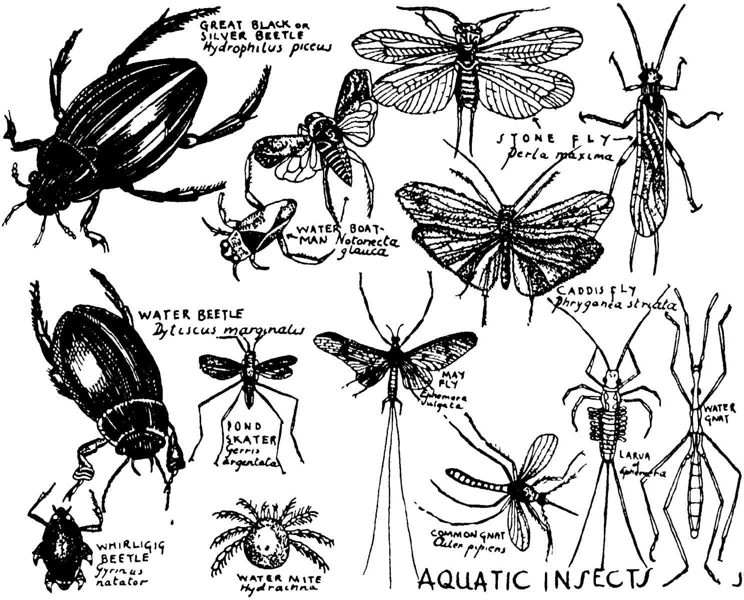
Let us first examine the aquatic insects, and so complete our brief survey of the insect world.

A certain bend in the Bourne, a stream in Wiltshire, is very familiar to me—the Bourne which begins as a remote stream on the east of Savernake forest and continues its snaky course till it runs into the Avon near Salisbury.

This particular spot is known locally as " Six Hatches." Screened from the road by thick rough hedges and clumps of nettles, it was known to the boys of the village as a bathing resort, and to me as a restful place for slumbrous summer afternoons.

One afternoon I noticed a black patch near the edge of the water. Peering down I saw it was just a clotted mass of tadpoles, huddled together in close formation. Every now and then they were moved by a sort of commotion. A thrill shot through the mass, and off they went, first in one direction and then in another. They were evidently afraid of something.

Their enemy was the larva of a dragonfly, a creature not unlike the tadpole itself in its pulpy nature, only armed with claws. It seemed to have that big mass of tadpoles completely under its domination, chasing them in various




directions. Eventually it seized one little laggard by its pulpy head, a carefully selected victim, and carried it under the bank to dispose of it at leisure. . . .

Although they look somewhat alike in their youthful stages, the dragon larva and the tadpole are, of course, in extremely different lines of evolution. The insect belongs to phylum Arthropoda, whilst the little amphibian belongs to Chordata, the phylum of the backboned creatures.[1]

Before they reach the winged stage, young dragonflies spend a year or more crawling over the bottom of ponds or streams, or climbing the stems of water plants, of reeds and rushes, in pursuit of other water-insects, worms, tadpoles of frogs and newts, little fishes, etc. The young dragonfly is well equipped for his hunting, for he has powerful cutting jaws, with the lower lip extended into a long jointed limb with a pair of sharp hooks on the end. From time to time they moult their skins, as they grow larger.

[1] The class *Amphibia* is viewed and described in Book Four, Chapter II.

Midway in the young dragon's under-water life there appear upon him two pairs of buds from his forebody above the hindmost legs, and later these reveal themselves as the developing wings, tightly packed against the insect's body.

One summer's day he climbs up the stem of a water plant and fixes the hooks of his feet securely in his support. His skin splits for the last moult, and he walks out feebly and hangs limply from the stem. In a short while his wings spread long and broad, his body lengthens and becomes brightly coloured, and gains in strength and firmness, and, without a sign from an instructor, the great green dragonfly discovers the use of his iridescent gauze wings that carry him at sixty miles an hour through the air. His great lamp-like eyes gleam in the brilliant summer's day, as he darts through the rustling air over reedy pool and purling stream.

He is one among great numbers of insects that fly over the inland waters during the long summer months. The dragon, however, may also be found some distance from pools and streams. There are plenty of insects found nowhere save over the surface of fresh water sheets.

" On a summer's evening late in May or in the beginning of June we see swarms of flies with delicate gauzy wings that measure an inch or so across, dancing up and down in the air over the edge of a stream or large pond, and often touching the surface of the water . . . their merry movements continue in the dusk till we can no longer distinguish their fragile forms . . . on the following morning we visit the spot again, but the swarms have disappeared. . . . In the evening we witness the same sight again, and perhaps for an evening or two after ; but their numbers rapidly diminish, and no more are to be seen till the following year. These insects are known as mayflies (*Ephemeridae*)."[1]

The Greek word *ephemeros* means " lasting but a day " ; and in the case of thousands of these mayflies their life lasts but a few hours. Like the dragonfly, however, they have spent a long life in an immature state under water. The eggs of the mayfly are little flat discs that scatter as they

[1] W. Furneaux, *Life in Ponds and Streams*, pp. 275–6.

sink through the water. The young larvae, as soon as they escape from the egg, burrow into the mud. In the sandy and clayey banks of lower rivers, they burrow great warrens that sometimes cover large areas and are inhabited by myriads of these ephemerids. Like the common earthworm they eat mud and digest out all that is of value to them.

"The larva always burrows into the mud head foremost, and the excavation is too narrow to enable the creature to turn. He prefers to rest at the mouth of his tube with the head just exposed. How is this to be managed? In this way. The larva burrows for a short distance downwards, and then works himself round till his tube forms half a circle and his head is directed upwards. Continuing in this direction, he soon reaches the surface of the mud again and settles down with his antennae just exposed, and ready to devour any nutritious matter that may be drifted towards him."[1]

For one, two, and sometimes three years—according to the species—these mayfly larvae dwell in their damp dark burrows. Although so well protected, they are not entirely safe, and when they venture from their retreats for short swims these little worm-like creatures are snapped up in great numbers by fish, a great part of whose larder is supplied by the larvae of all aquatic insects. The fish of the streams do not confine themselves to larvae, but will eat the perfect insects when at length these emerge; and such is the fate of many thousands of mayflies on the day that they take wing. "As any angler knows, the rising of the mayfly is the beginning of the happiest period in the lives of river-fishes, which have so little time to wait before the exhausted insects fall back, many of them to drift upon the water into the snapping jaws that await them."[2]

No wonder the mayflies are quickly exhausted! Like certain moths and butterflies, they have no mouths and cannot take any food. The effort of egg-laying is too much for them. These creatures are worth waiting for and watching during their brief flight and mating time. They are

[1] W. Furneaux, *Life in Ponds and Streams*, pp. 278–9.

[2] Kathleen E. Carpenter, *Life in Inland Waters*, p. 170.

fragile and beautiful. They have two pairs of delicate, transparent, finely-veined wings, the front ones being long and broad, but the hind pair very small. The antennae are short, but the front legs are long and slender and are thrown forward when the insect flies, so that they look just like a pair of tapering antennae. From the back of the body several straight hairs stick out like a fine brush tail. Like other insects the mayfly has a pair of compound eyes.

Another common insect who performs this round, having an aquatic larval stage before taking to the air, is the stone-fly (*Perla marginata*), so-called because of his habit of resting on stones on the banks of streams. This is a brownish-yellow fly with a broad flat body and wide head, having nothing of the streamline of dragon and mayfly, and far more sluggish in his movements. The male of the stone-fly is often but half the size of the female, who lays several hundred small black eggs. The larvae hide under stones, eating all that comes their way. They have four wings, and wide-spread legs with two-clawed feet.

Perhaps the most interesting of all these aquatic " flies " are the caddis flies, whose larvae, called caddis worms, build homes for themselves on the bed of the stream. These caddis worms are, of course, not worms at all, and the flies that emerge at length from the larval stage are not true flies, any more than are mayflies or stone-flies. All these so-called " flies " have four wings, whilst true flies, as we have seen, belong to the *Diptera*, " the two-winged." Caddis flies are not likely to be mistaken for true flies : they more nearly resemble moths, as they have hairy wings, the hairs forming into colour patterns. But here again, we remember that moths and butterflies belong to the *Lepidoptera*, " the scaly-winged." Scientists have placed the caddises in a class of their own, *Neuroptera*, " the veined-winged " in the order *Trichoptera*. Appearances and popular names are about as deceptive as each other. Scientific names alone are worth knowing.

Almost as soon as they are hatched from the egg the larvae of the caddis flies set about building their homes.

There are as many different kinds of these homes as there are kinds of caddis. Some build roomy huts of small pebbles fastened on to larger stones. Silk-spinning larvae weave cases of this material for themselves, which they close up at the end during the winter months. Other caddises collect the empty shells of fresh-water molluscs and stick them together with a cement of their own making until they form a sort of tube in which the tiny creatures live. Yet others construct tubes of sand, finely fitted together. Others again will bite off bits of roots and leaves and cement them all up together. Caddises believe in having plenty of room, unlike the mayflies' larvae who burrow into the bank and then can't turn round in their own burrows.

Certain caddis worms share with men and spiders the distinction of being about the only creatures in the world of nature who make a trap for their prey. Not content with waiting for what the flowing waters will bring to them, they weave a web outside their hut, full in the path of the rushing stream, far out into the current, among bare stones. Other species, not web-spinning, drag their cases about with them, like hermit crabs, in the constant search for food.

Caddises grow by a series of moults and have a final stage of pupation before the emergence of the perfect insect. The hairy-winged adults are short-lived, and never fly far from brooks.

**Common Gnat** (*Culex pipiens*). It is about time we made certain that there are true flies in the river. The most common of all aquatic flies is the gnat, whose buzzing is familiar to everyone, and whose " bite " is the prick of the female's upper lip, which is a beak-like tube with which she sucks blood for food. She does not poison her victim : indeed, a gnat bite is the mildest possible affair. The gnats possess beautiful plumed antennae, the plumes of the male being the more magnificent of the two. Their long narrow curved wings are clothed with tiny scales. Their legs are very slender and long. The female, clutching on to any floating object, lays some two or three hundred eggs, which

she glues together in such a manner that they form an "egg-boat" or raft. This little boat of eggs is practically unsinkable. In a few days the eggs hatch ; a sort of door opens on the under-side of each egg, a larva enters the water, and the door closes again. The larva now spends a free life in the water—a long-bodied creature with a large head and chest. He has no limbs and swims by wriggling. Near the end of the body is a bristly tube which sticks above water, for breathing. While air is being taken in, the larva is being suspended head downward from the surface. The growing larva moults several times, then becomes a pupa that appears to have a huge head ; but this is really a skin enclosing wings, head, thorax and legs of the developing gnat. The pupa swings from the under-side of the surface of the water and is furnished with two curved breathing tubes which stick out into the air. When the pupa breaks, the new-born gnat can come out without getting wet, and the insect uses the old pupa case as a raft on which to dry and expand his wings before he takes flight.

Water Gnat (*Hydrometra stagnorum*). The water gnats are not related to the true gnats. They are not flies, but members of the Hemiptera, the order to which belong the aphids, bugs, cicadas, scale insects, and such water creatures as pond skaters, water boatmen, water bugs, water scorpions, etc.

Water gnats are to be found in great numbers during the summer months on ponds and quiet lakes, in slow-flowing streams and rivers, and on backwaters and quiet pools. They appear at first sight to have eight legs. However, they have only six, with two long antennae that can easily be mistaken for two more legs. The slender body is no thicker than a pin. It is distinctly segmented, covered with chitin, with only the stumps of wings remaining. The long head of these creatures is shaped somewhat like a dumb-bell, and the eyes are set one on each side in the very middle, at the thinnest part.

The water gnats are one of those creatures that, while

dwelling upon ponds, do not swim on them, but walk on them, using the elastic surface-film as a carpet. Only the frailest, lightest and most cautious forms of life can move over the water without breaking the surface-film and getting wet. A very wonderful thing is the surface-film on water. Fill a glass to the brim, and then gently pour as much more water as you can into the glass without letting it overflow. The water will mount over the rim, and hang and tremble there, held by the unbroken surface-film, until at one point the strain becomes too great, and the liquid pours through the rent in the film. The film, we see, is a real film, with no little power; and it makes possible the way of life adopted by water gnats, pond skaters and several other aquatic insects.

**Pond Skater** (*Gerris argentata*). Whereas water gnats walk sedately on the water, their close relatives, the pond skaters, slide and leap on the surface-film without breaking through. They are not unlike water gnats, but are bulkier in appearance, with rounded bodies and stumpy heads; their bodies are covered with short velvety hairs which, when the insect dives to avoid foes, retain the water so that the little creature looks like a bubble of quicksilver when swimming. The body of the pond skater is kept dry, even under water, by the air retained by these hairs. Fragile creatures as they are, pond skaters cannot break through the surface-film of water except by diving. If pressed through by a human hand they may be unable to break their way back again. The larvae skate on the surface-film, much like the adults.

**Water Boatman** (*Notonecta glauca*). The name "notonecta" means "back swimmer," and the water boatman swims on his back, which is bluntly keeled and resembles a boat in shape. The last pair of legs are the longest and hairiest and the insect swims by paddling these through the water with an action not unlike that of a pair of oars. It is a beautiful motion to watch: when pressing against the water the limbs are held straight and the hairs stand out, to cover the maximum surface of water: when they are

drawn back the legs bend and the hairs lie against them so as to produce the minimum of friction. The middle pair of legs generally assists the hind pair in swimming, but it is the latter that does the real work. The front pair of legs is used mainly for seizing food and for anchoring the body to weeds. The water boatman is a strong flyer as well as a good swimmer, and his wings are extremely beautiful and complex. He has two pairs of wings : an outer horny pair of three multicoloured parts : this pair acts more as a sheath or shield than as organs of flight ; and an inner pair, which would be almost invisibly transparent were it not for the iridescent colours produced upon them by refraction.[1] This strange creature, who can fly powerfully, and can row or scull himself swiftly over calm surface waters, has yet one other accomplishment to his credit. He dives the ponds to the bottom and spends a good deal of his time scavenging on the bed. He will fearlessly attack an animal larger than himself, hold it firmly in his forelegs, and then suck its juices until little or nothing is left but a mere skeleton. The strong sucking beak will be used by the boatman as a weapon of offence or defence, and if he strike it into your hand the bristles with which it is clothed will produce no little irritation. There is no poison, however, and in a minute or two you will have forgotten all about the event.

**Water Beetle.** Coleoptera, the beetles, not only form the largest single order of insect, but actually the largest single order in the whole animal kingdom. Round about 180,000 species have been discovered and described : there are probably more than 200,000 species in the world. There are 3,500 species of beetle in the British Isles alone, which include such well-known species as the destructive Death Watch beetle, the furniture beetles, the cockchafers, the glow-worms and the lovely and beneficent ladybirds. In general, the beetle clan contains some of the largest existing insects and some of the smallest : there is a tropical

[1] See p. 132.

beetle whose body-length measures six inches, and there is a beetle who never increases beyond the almost microscopic size of ·5 of a millimetre.

Of the water beetles we cannot do better than take as our example *Dytiscus marginalis*, who is as large and interesting a creature as one would wish to meet with in the beetle world. Dytiscus is more than one inch in length. He is a fierce, restless creature, with strong biting jaws (with the beetles we leave the beak-suckers behind us). He will actually seize fishes as they swim and mercilessly devour them as they struggle hard to shake off their foe. Even molluscs are not safe from him, for the beetle can bite through their shells to feed on the soft bodies within.

*Dytiscus marginalis* may be found in ponds more or less all the year round. Unlike most insects, he can survive more than one winter—a large dark brown beetle he is, with a tinge of yellow in the forepart : a shiny horny back, he has, and a spiny prickly stomach. The structure which we saw in the last insect, the water boatman, is the typical form of beetles (it is true that the water boatman is not a beetle : he belongs to the Hemiptera ; but there are no letters patent in the world of nature)—a hard sheath-like pair of wings outside, of more use for defence than for flight, an armour-plating for the true wings within, though in some species these outer shields are used for gliding. His eyes are large and very prominent, and are so placed that he can look upward and downward at the same time—a convenience of no little value for so active a creature, who will be one moment flying through the reeds and next diving through the surface to attack some fish on the bed of the stream. When he dives Dytiscus carries down with him under the tail a supply of air which he breathes while under water. When this is exhausted he must swim to the surface for a fresh supply. Like all beetles Dytiscus goes through a complete metamorphosis.

**Whirligig Beetle** (*Gyrinus natator*). These small beetles may often be seen on a brook or pond in August, sliding

about the surface in a mazy pattern. Turning and twisting with a speed that baffles the eye, they are pursuing the minute insects whom they have made their special prey. They can fly and dive (taking their bubble of air with them), can seize and bite their prey ; but spend a great deal of their time whirling their light bodies over the surface-film ; so that they seem to combine most of the achievements and activities of the last half dozen insects at which we have looked. They are about a quarter of an inch in length.

The last of the water insects at which we can look are the aquatic moths. Most people seem unaware of the fact that certain Lepidoptera spend a portion of their lives beneath the water. Of the many hundreds of species of British moth, but five are aquatic—and all belong to a family called the *Hydrocampidea,* the insects being known popularly as the "china marks," on account of the pattern on their wings.

They are slender-bodied insects, with long and slender legs provided with long spur-like bristles, and the females are larger than the males. The mothers creep down the under-water stems of pond and stream plants, to lay their eggs on the bed ; and they can climb back again into the air with wings quite dry, so close-folded have they been. Caterpillars of these moths are for a time purely aquatic creatures, dwelling and feeding in the depths ; but as they grow through their series of moults, they lose the power of under-water breathing, and must come to the surface to get their supply of fresh air. These creatures construct their cocoons in much the same manner as some of the caddis worms make their cases.

END OF BOOK THREE

# Book Four

# Fish, Flesh and Fowl

In the first three Books we have caught glimpses of mankind in relation to the world of nature—of man as an ordering mind, seeking and finding the true relationships of creatures (Book One, Chapter I): of man depending upon grass for bread and meat (Book Two, Chapter V): of man engaged against the insects in a struggle for possession of the earth, and using some insects themselves as allies in this struggle (Book Three, Chapters I and V): and now, in this last Book, as we approach the higher types of creature, we view, in glimpses, fresh aspects of this connection man bears with the animal and vegetable world: we see (Chapters II, VI, and others) the sport man obtains from the creatures. We glimpse man's deep connection with the lowly amphibians and reptiles (Chapter III) in the evolution of his own body. . . . But this is not the only feature of this last Book, which describes in detail the lives and forms of creatures so varied as spiders and leeches, game fishes, and the whole mass of British birds, amphibians, reptiles and mammals.


THE OAK WOOD

# CHAPTER I

# SPIDERS

SINISTER LEGENDS have grown up about spiders, probably because they are one of the few animals in the world who construct traps to ensnare their prey. The spider's trap, the web, is of silk, like the cocoon of the silk worm, but although attempts have been made to use this silk for human purposes, spiders' silk remains of use only to spiders.

Now, in spite of their reputation, spiders are perfectly harmless creatures ; and just to show you how easily they have achieved a false reputation, let us consider their classification. Most people would say, off-hand, that spiders are insects, when, as a matter of fact, they are not.

Insects have six legs, whilst spiders have eight. Insects (with few exceptions) have two compound eyes, spiders have eight simple eyes. All insects have their body in three parts, but spiders have only two parts. The front part of spiders, called the cephalothorax, combines the head and chest of insects ; the back part is the abdomen. These two parts are joined by a very slender link. For these and other reasons it has been shown that spiders are related to quite another class of creature in phylum *Arthropoda*, and not to the insect class at all. They belong to the *Arachnida*, to which belong scorpions, mites, and a few odd creatures such as the king crabs of the American coast of the North Atlantic.

So much for reputations !

Now let us consider this extraordinary creature, the spider, as he really is.

Once he has discovered that he can produce silk, the spider turns this achievement to account upon every important occasion of life. The spider is born into a silk nursery—which is the silken cocoon spun for her children by the mother spider. Soon after they are born, spiderlings begin to find their nursery uncomfortably overcrowded; for there may be anything from ten to 2,000 brothers and sisters to live with. Different species of spider vary greatly in the number of eggs they lay, although ten is an unusually small number and 2,000 an unusually large one.

Soon, however, the spiderlings break out of the crowded cocoon, and at once begin to climb to the highest point in the neighbourhood—the top of a blade of grass, maybe, or perchance the towering summit of a fence or railing. These new-born spiderlings are perfect miniature spiders, and do not pass through any metamorphosis.

Reaching the height of their ambition, the first instinct of the spiderlings is to spin; and out of their spinnerets at the back of their abdomen comes a wavy thread of silk. This thread is drawn out by the slightest breath of wind into a streamer several feet in length. Sometimes the spiderling will send out several of these streamers that float and wave in the air until they have enough buoyancy to carry him aloft: when that moment comes, the spiderling lets go with all his legs, and rises into the air, like Sinbad the Sailor on the magic carpet.

Away go the spiderlings, sometimes but for a few yards, sometimes for many miles, scores of miles, to pastures new. . . . In this method of dispersal they seem to have taken a leaf out of the book of the plants. Many of the ballooning spiderlings come to rest a mere few feet from their starting point, where the scores of streamers, trailing over a hedge or paling, produce the familiar gossamer. Unlike the seeds of plants, however, the ambitious spiderlings can "start again," can climb up and spin fresh kite-threads and sail away once more on the breeze.

Having at length found a place to his liking, the spiderling at once begins the serious business of life—spinning.

He commences the spinning of the web. The webs of spiders vary as much as do the nests of birds. Each species has its characteristic web, although the method of building varies a little according to the site, and to the direction of the wind, and even to the number of insect-prey in the district. We shall view the web and its making more closely when we examine the different species of common British spider.

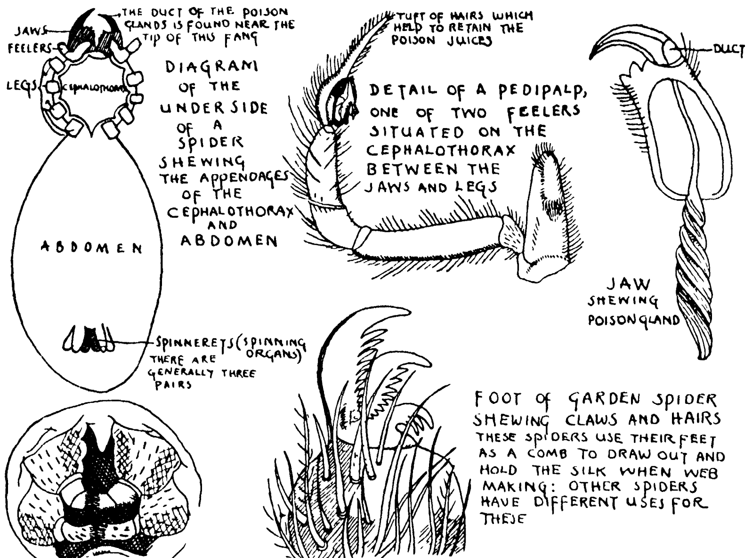
When the web is spun the spider waits for his prey, hidden from view, but touching a thread from the web. The hidden spider feels rather than sees the insect tangled in the web ; for, in spite of eight eyes, he is very short-sighted. However, vibrations such as those caused by the wings of a flying insect are sent along the taut threads of the web, and announce to the spider the fly's approach.

Once a fly is entangled, the spider hauls himself up and runs out across the web with great speed, and spins more threads to lash the unfortunate fly to the web. If the spider is hungry, he may devour the fly there and then. If not, he will carry off the fly to his larder, a hidden lair near the edge of the web, where he will hang up his victims by silken threads until he is ready to make a meal of them.

And this is really the transition from spiderling to spider ; the spiderling, of course, grows with what he feeds on, and, like the crab, he has to grow through a series of moults. All spiders feed on insects, and in most cases they kill their prey by a poison which issues from them. They eat their victims by sucking all the juices their bodies contain : spiders can eat only liquid food.

In order to gain a closer view of this remarkable creature, let us examine a few specimens of our British spiders.

**Common House Spider** (*Tegenaria atrica*). This spider, who probably lives in every house, shed, stable and garage in Britain, is the maker of those " cobwebs " which will always be found in undusted corners.



DETAILS OF SPIDER·ANATOMY

This common house spider is eleven millimetres long. His cephalothorax is reddish brown, with black bands at the sides. His abdomen is yellowy brown with a series of black triangles along the middle and rounder black spots on the sides. His web is a triangular sheet of silk with its innermost corner shaped into a short tube, in which the spider lurks. This web may be known from the webs of other spiders by a thread running from this tube, out over the whole web to join with the farther edge of the sheet.

The making of this web is a leisurely business. The common house spider does not believe in speed. " On the first evening after his arrival the house spider walks round his domain and lays down a few threads of silk, the limits and scaffolds of the building to come. Nightly thereafter, and at odd times, the spider wanders over these threads, and, as he does so, one may notice his long spinnerets in action, his abdomen carried with a curious swaying motion, broadcasting silk. Thus the web grows gradually ;

it never reaches a point at which the owner can say, 'Hold, enough!'; always it gets thicker and stronger as long as the owner lives in it."[1]

Another house spider is *Tegenaria derhamii*, not so common as the former but a good deal larger, being about 19 millimetres. He has great hairy legs, 50 millimetres long. His markings and general colour are very similar to *Tegenaria atrica* but his abdomen has a khaki stripe down the centre, into which run several pairs of khaki stripes from the sides.

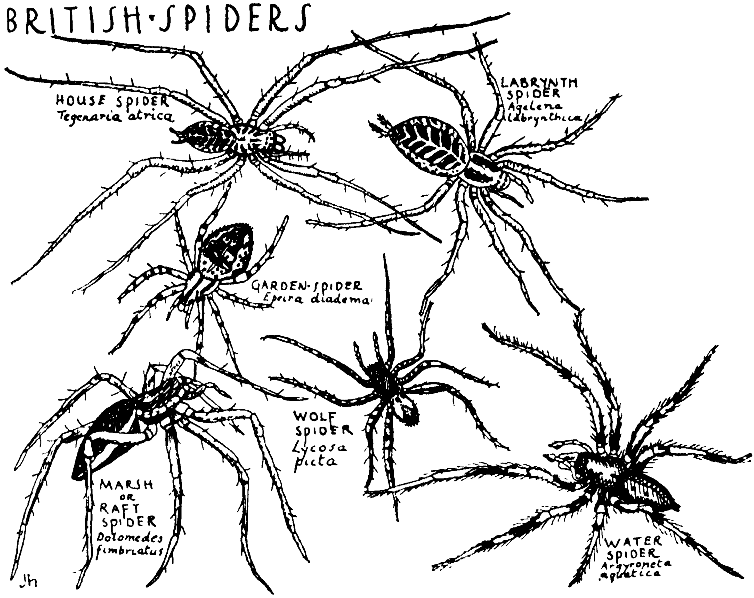
A still larger spider, *Tegenaria guyonii*, 20 millimetres long, with legs of 60 millimetres and more, is found only in the midlands and south of England, where he is called the "cardinal." There is a red-brown band down the middle of the abdomen, running between two pale yellow spots with uneven black borders. The sides also are streaked and spotted with black.

**Labyrinth Spider** (*Angalena labyrinthica*). This common spider is a close relative of the house spiders, but is found out of doors. His large shining white web is found in July, August and September, especially upon gorse bushes or among rough grass. This spider is 13 millimetres long, brown cephalothorax, darker abdomen marked with paired grey bars on upper side, which almost meet in the middle, forming a mark like a convict's broad arrow. Like the house spiders, the labyrinth spider stands in a tube constructed of woven threads, beside the web, waiting for the welcome vibrations. At moments of peril he escapes out of the "back door" of the tube into the gorse thicket or long grass.

**Garden Spiders.** Though the labyrinth spider and many other species are commonly found in gardens in Britain, the spiders to whom have been given the proper name of garden spiders are the family *Epiridae*, who are perhaps the most interesting of all British spiders. The web of *Epeira*

[1] Theodore H. Savory, *British Spiders, their Haunts and Habits*, p. 68.

*diadema* is the wonder of spiderdom ; and we can only glean an idea of its structure by watching it being built. Anyone who has access to a garden in summer time should stand a chance of seeing this marvel, since most of these garden spiders have to re-build their web each day, owing to wear and tear. The building of the web takes nearly an hour. The spider begins by forming a rough square of thread, each corner attached to some object. He first fixes a thread to a starting-point, then drops down to the ground with it, crawls along and up another object, all the while holding the thread free of obstacles by one of his back legs held out behind him. Reaching a certain height he draws the thread taut between the two objects, and so has an aerial ropeway, from each end of which he drops in turn, on threads that he fixes to the ground, or to objects below on which he lands. He then connects these two bottom ends with a fourth thread which forms the base of a rough square of thread. Often enough, the spider finds it impossible to crawl about, holding threads behind him ; and then he makes use of his old friend, the wind, sending out streamers which will stick on to the object across the way, streamers that, when hardened, will bear the weight of the web thread. When the square with cross-lines is completed, the spider travels all round it two or three times, adding a thread on each journey, thus giving the outer framework two or three thicknesses of thread. The next job is to connect up the sides, which he begins to do by joining the four corners of the square by two threads stretched across the middle. He next runs threads from the middle of each side to the middle of the opposite side, and goes round laying threads across until they look like the spokes of a square wheel. He reveals an almost unerring instinct in this work in the way in which the angles all round turn out to be as equal as no matter. The spider then returns to the centre of the web, and moving outwards gradually lays down a temporary scaffold to move about upon while the work is being completed. From the outer edge the spider then begins to lay down a long, long sticky thread, which goes




round and round the whole framework, attached to each "spoke" thread, stretching tight and straight between each two spokes, round and round and gradually inward towards the centre : this is the snare for the insect prey, the sticky thread in which they will get caught, from which no struggles will avail to free them. When a little way from the centre, the spider breaks off this thread, then takes down the scaffolding, tidily eating it out of the way. The final job is a spiral thread added in the centre. All web-building is a variation of this plan, though few if any British spiders achieve such spectacular work as *Epeira diadema.* This garden spider is a plump creature, with an almost globe-shaped abdomen, dark brown in colour, often with little conical knobs upon it. It is among these spiders that the traditional domestic tragedy of the race most often occurs ; for the male is a small creature compared to the female, who is inclined to be ferocious and to gobble up any little male who fails to please her. As in the case of nearly all British spiders, the male has an uphill task in his

wooing and spends some time entertaining the female with a dance. It is even said that the lady will in time gobble up her chosen mate. In the labyrinth spiders, this rivalry seems hardly to exist, the male and female being often found living " happy ever after."

**Wolf Spiders.** Most of us have been surprised by dark brown spiders that scamper away as we pass through fields and meadows in spring and summer. These are the vagabond spiders " that spin no webs and have no nests, the tramps and huntsmen of spiderland, with no home but the wilds and no roof but the open sky." The only time when they cease from a life of wandering adventure is when the mother wolves spin their cocoons and rear their young ; and in this they show themselves superior to most web-spinning spiders. Most web-spinning spiders, having laid their eggs and woven a cocoon around the eggs, take no more notice of their young. But mother wolf attaches the cocoon to her spinnerets and carries it about with her. The wolf spiderlings are born while still unable to care for themselves, so they climb upon their mother's back and are carried there for days and even weeks, before scattering to their normal lives. There are twenty or more species of wolf spider in Britain. One species, *Lycosa purbeckensis*, is half a sea creature and may be found on the seashore amid seaweed. He is covered with longer hairs than are found on most spiders, and when the tide rises, these hairs hold the air which the spider breathes until the tide goes down again. During high tide he will cling to the stem of a seaweed plant. Another species, *Dolomedes fimbriatus*, is the famous raft spider of the Cambridgeshire fens. The female is a magnificent creature, nearly 25 millimetres long, a strikingly marked spider of a dark brown colour with two whitish yellow stripes on the abdomen, that render her very inconspicuous among the rushes. She has earned her name from her habit of constructing, out of a few dead leaves and threads of silk, a small raft on which she sets sail on the face of the waters. From this raft she runs out on

the surface of the water in pursuit of prey. These are sometimes called marsh spiders.

**Water Spider** (*Argyroneta aquatica*). Of all the species of spider in the northern hemisphere, but one alone has taken to under-water life. This water spider is a very remarkable creature indeed, for he does not breathe like a fish, but carries a bubble of air about with him beneath the surface. Indeed, he practically lives in a bubble of air, like a man in a diving bell, and has continually to return to the surface when the air gets used up. This spider spins a dome-like silken home under water, which he fills with air by bringing down bubble after bubble in his long hairs. By means of this air the silken dome floats under the water, anchored by threads of silk. For several years the water spider lives in this manner, making a deeper and stronger winter dome and a lighter and frailer summer one. The courtship of the male water spider is as quaint as any in the world of nature. He spins a silken dome near that of his lady love, fills it with air and then joins the two by a silken passage. Such industry and ingenuity deserve their reward. The water spiders are very ordinary-looking spiders, dark brown without a pattern. Almost the only difference between the water spider and ordinary land spiders lies in the fourth pair of legs, which have hairs that are long and curved like an eyelash, instead of being straight like the hairs on the legs of other spiders : these assist in holding the air under water ; but except for a slight difference in the eyes, he is in no way adapted to under-water life, so that his strange mode of existence is all the more remarkable.

**Trap-door Spider** (*Atypus affinis*). This species may be very rare in England. On the other hand, he is such an expert at concealing himself, he is probably more numerous than naturalists suspect. His habits of life are quite unlike those of other spiders. He digs a deep cylindrical burrow, as a rule in some well sheltered bank or dell, and lines this

burrow with a silken sleeping bag which is woven out to form a small web amid the vegetation. When an insect gets entangled in the web the spider, lurking in the burrow underground, strikes at the victim through the silk, and drags the unfortunate insect down to the bottom of the burrow, afterwards repairing any damage the web may have suffered. These spiders have been known to eat worms that have invaded their burrows. The female *Atypus affinis* never leaves her burrow when once she has completed it. The male's burrow is shallower and he will leave it upon many occasions. The young are found in the nests, in their mothers' burrows, in spring and autumn (many of these spiders having two families a year).

. . . . . . . .

There are about 40 families of spider known to science. Twenty-three of these families have representatives living in Britain. This gives us over 540 different species of spider at present recorded as British. Of course, we cannot give a complete list of these creatures here, but perhaps enough has been said to enable anyone to identify the most common and interesting kinds and to understand their lives and habits ; and this will induce the keen reader to study the less known species who are to be found in our island.

# CHAPTER II

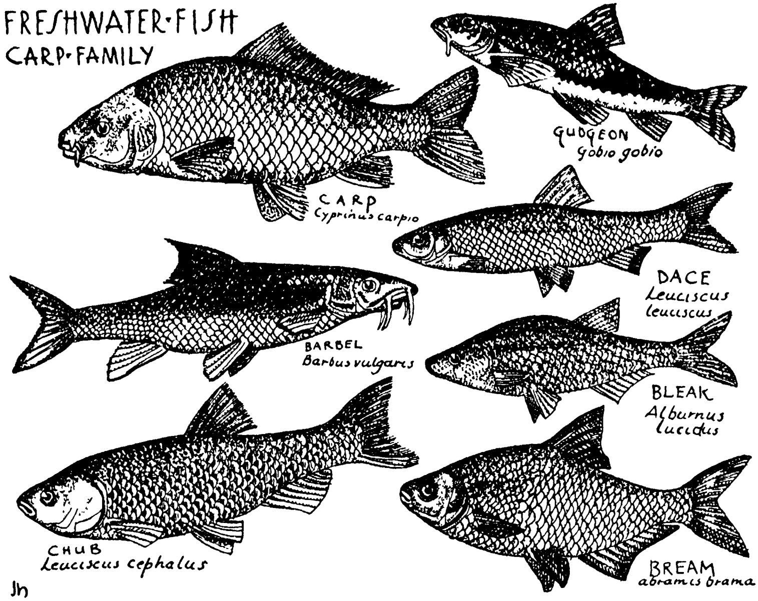
# GAME FISHES OF RIVERS AND LAKES

*Man's life is but vain, for 'tis subject to pain*
*And sorrow, and short as a bubble ;*
*'Tis a hodgepodge of business, and money, and care,*
*And care, and money, and trouble.*
*But we'll take no care when the weather proves fair ;*
*Nor will we vex now, though it rain ;*
*We'll banish all sorrow and sing till to-morrow*
*And angle, and angle again.*

THIS WAS the philosophy of Izaak Walton (1593–1683) whose book *The Compleat Angler*, published in 1653, was the first guide to fishing and the first real description of the fish that are in the streams and rivers and lakes of Britain.

Fishing, as Izaak Walton showed, is not a sport that needs no learning and no practice. The more you know about the fish you want to catch the better chance you stand of catching him. We saw in Book One, Chapter VII, how men had learned the times of the coming and going of the salmon and the eel, in order to make the greatest haul of fish without destroying the fish that would breed and carry on the race for future seasons. That is elementary knowledge ; and to-day fishing is a fine art and a science.

For instance, most river fish eat insects ; and the best way to catch these insect-eating fish for sport is to have as your bait an imitation insect. The range of these manufactured " flies " is now vast ; and certain kinds of these artificial flies are used to catch certain kinds of fish.




Fishing is a great sport ; but from our point of view in this book it is more than a sport, because it needs at least some knowledge of the natural history of fishes. Izaak Walton found that fishing gave him an opportunity for understanding the life of the country in all its forms and moods ; and that is part of the fascination of fishing to-day.

To-day, when they get the chance, hundreds of thousands of men and boys in England, break away from their life of "business and money and care," break away from the smoke-begrimed cities and the roar of our civilisation, to find a quiet brook or purling stream, the broad reach of a river slowly and smoothly flowing, or the bright silver lapping waves of a lake or pond ; and there they sit, with rod and line and basket, waiting for fish to bite. . . .

On hot sunny days, carp may often be seen in threes and fours, cruising lazily around near the surface of a fair-sized stream that is not too swift-flowing. Now and again they stop to inspect something which interests them. Perhaps they see a morsel of food floating on the surface.

Snap ! One of them gobbles at the morsel—and feels a strong steel hook catch in his jaw. He wriggles, and attempts to flee. The hook goes with him as he swims, then tightens and pulls at his mouth, so that he turns in desperation to swim in another direction.

The hook goes with him again, tightens once more ; and soon, he is being drawn by the hook, pulled nearer and nearer to the surface—to be yanked out of the water, up into the sunlight and the free air, on to the bank, by the fisherman. . . .

We take the carp first in our brief survey of the fishes of the inland waters because the carp is the head of the largest of all the families of freshwater fish. This family includes bream, chub, dace, gudgeon, minnow, roach, rud, tench, barbel, bleak and others, not to mention the goldfish of garden ponds and glass bowls. Like the goldfish, which comes from the Orient, the carp is a native of Asia, but he and his family have been so successful in the fresh waters of Europe that they now far outnumber all other sorts of fish in streams, rivers and lakes.

" The carp is the queen of rivers," said old Izaak Walton ; " a stately, a good, and a very subtle fish ; that was not at first bred, nor hath been long in England, but is now naturalised."

Our wild carp are thought to be descendants of fish that were first brought into the country and kept by the monks who fished for them for centuries.

## THE CARP FAMILY

*(Cyprinidae)*

**Carp** (*Cyprinus carpio*). The carp is one of what the fishermen call the " coarse fish," because it is not very good eating. The coarse fish are none the less good sport. All the carp family are coarse fish, as are pike, perch, loach, and several more. The carp, a reddy-brown fish, has four barbels, two on each side of his mouth. The barbels of fishes are, in a manner of speaking, not unlike the antennae

of insects ; for, although the antennae of insects are jointed little rods, thin as threads, and the barbels of fishes are cord-like whips of flesh springing from around the mouth, the barbels, like antennae, are feelers, and are used by the fish for examining food and other objects. Not all fish possess these feelers.

The carp has an unusually long dorsal fin. His brain is remarkably large and from early times he has won a reputation for cunning ; which is why fishermen dub him " perhaps the shyest fish that swims." The carp eats almost anything, and such things as green peas, cheese, boiled wheat, wasp grubs, and half-cooked chip potatoes are used as bait for him.

Carp lay their eggs in May or June, of which one female may lay more than 600,000. These eggs are laid in jelly-like masses on the leaves (fronds) of water plants, and the young hatch out in three or four days.

**Barbel** (*Barbus vulgaris*). This fish gets his name from the four barbels, two on each side, which, as in the carp, hang around his mouth. This fish differs from the carp in having a short dorsal fin, and a longer snout than that of the carp, and a leaner body. He has a small eye, set rather high up on the head. The colour of the barbel varies, but is most often dark greenish with golden tints on the sides. Small dark brown spots are often present on the back and sides and on the dorsal and anal fins. The barbel is not found in mountain streams or swift brooks, nor in the slow-flowing lower reaches of rivers, but in the quiet middle reaches ; his chief homes are in the Thames and Trent. In May and June the eggs are laid on gravelly beds, being covered over with gravel by the parents. They hatch in about a fortnight. The barbel is a coarse fish. The roe is poisonous.

The name " barbel " comes from the Latin *Barbellus* from *barba*, a beard.

**Gudgeon** (*Gobio fluviatilis*). The gudgeons are round-bodied, brown-backed fish that somewhat resemble miniature

barbels, but have two barbels only. They have, for their small size, a large eye. They rarely grow to more than six inches, and are found mainly in fresh, swifter-running rivers. Gudgeons feed in shoals on the bottom. A female lays between 1,000 and 3,000 eggs throughout the summer, in small clumps that lie on the bottom. These eggs hatch in about ten days.

Tench (*Tinca vulgaris*). The tench is only found in still waters, in small lakes or ponds, especially those with many water plants and a muddy bottom. A sluggish fish, liking the weed-shadowed darkness, the tench may be easily known by his greenish-bronze colour, small bright red eyes, and the minute scales embedded in the skin and covered with a thick slime. The snout of the tench is blunt and carries a short barbel on each side. Tenches may grow to be about a foot and a half. Eggs are laid from April to August, in little clumps, on water weeds. A female tench produces about 297,000 eggs in a season. They hatch in about a week.

Minnow (*Phoxinus phoxinus*). One of the smallest of our freshwater fish, the minnow rarely exceeds a length of four inches. A beautiful little creature, the minnow is varied in colour, most often being silvery grey, shot with green, gold, brown and black. Minnows prefer clear streams with a sandy or gravelly bed ; but they often journey in shoals to fresh reaches in search of food. They are venturesome fish, and will follow daring leaders. They spend the winter in deep water, in the summer foraging in shallows. They eat chiefly insect-larvae, worms, freshwater crustaceans and molluscs, and the eggs and small fry of other fishes : these are, of course, the main food of all river fishes, though, as in the sea, the larger the fish, the wider the menu, since the larger fishes can add the smaller to their banquet. Thus, the minnows fall victim to most of the larger fish, especially trout, perch, pike and eels. They are used by fishermen as

bait for these larger fish. They are also often added to man's menu, when they are known as " whitebait."

Minnows lay their eggs from May to July in shallow sand or gravel banks, often gathering in thousands to do so. Each female lays about 1,000.

**Chub** (*Leuciscus cephalus*). Anyone peering cautiously over the bows of a boat on some bright sunny summer day may see a shoal of chub swimming in and out the maze of roots of a willow tree that overhangs the water. This is the favourite retreat of the chubs, where they feed on beetles and caterpillars and other insects that fall into the water from the overhanging branches. They are, however, of a roving disposition, and may eat almost anything that comes their way. The chub may grow to a fair size—about two feet is probably the maximum—and has large scales that are darker where they join the skin than they are at their tips. In general, his colour is bluish black, on the upper parts, passing into white on the belly ; the cheeks and gills are a rich golden yellow. He has a large mouth. May and June are the egg-laying months, about 100,000 eggs being a fair number for a female to lay. These eggs are in sticky masses which cling to stones and water-plants and hatch out in about a week.

**Dace** (*Leuciscus vulgaris*). The dace is a graceful and silvery fish, distinguished from the chub by being more slender and lighter-coloured, and generally much smaller, but rarely exceeding one foot in length. He inhabits the same streams, but goes up further towards the source than the chub. One of the best sporting fishes, the dace will put up a great fight with the fisherman, and always " pulls his weight "—literally—when hooked. Eats flies, water-insects, crustacea and worms, sometimes water-plants. Egg-laying in April and May.

**Roach** (*Leuciscus rutilus*). Roaches vary, some being almost as slender as dace, others rounded like the rudd.

They are also found in varied places, being as at home in ponds and canals as in strong-flowing deep rivers : this is rather unusual : most river-fish, such as dace and barbel, cannot live in water that does not flow. The roach is therefore a variously-living fish ; and may sometimes feed on the bed of the stream and sometimes on the surface. A lively and crafty fish, usually swimming in shoals, the roach may be from 10 to 15 inches in length, is of a silvery hue, with a dull green back, and has no barbels ; the fins tinged with dull red. Eggs are laid in April and May in shallow water on water-weeds and submerged plants. They are small and transparent and hard to find. In about a fortnight the young hatch out, and rest quietly on the bottom for a week or ten days, absorbing the yolk-sac, after which they swim about in dense shoals among the water-weeds near the banks.

**Rudd** (*Scardinius erythrophthalmus*). Known as the red eye, the rudd is a very similar fish to the roach, being most easily distinguished by the brighter red of the fins and the bright red eye. The rudd is an inhabitant of sluggish rivers, lakes, ponds, canals, and other still or slow-moving waters. Habits are otherwise the same as those of the roach.

**Bream** (*Abramis brama*). The bream is a silver-grey or brownish fish, with bluish-grey fins : this fish may measure over a foot in length. A clumsy-looking creature, fat and broad, with none of the stream-line of such fish as the dace. A still-water fish by nature and design, the bream is yet found in several deep swift rivers, and is by no means the sluggish creature he looks. " Bream sometimes cover quite long distances in search of food. When doing business in earnest, they rout about in the bottom, turning the mud with their noses on the look out for hidden treasure. They will move up a still watercourse anything from 100 to 200 yards a day, clearing up the food as they go, and covering, before they finally finish, a distance of several miles. Their location can always be fixed for certainty, provided the

direction in which they are travelling is known, for the water becomes churned up, thick and muddy, and remains so for some little time."[1] The bream is shy and crafty, hiding in the mud he stirs up from the bottom. The eggs are laid in May and June, and at this time the bream shoals seek shallow waters near the banks. Here the fish make a great noise, leaping and splashing at the surface. The sticky eggs are laid on water-plants, 2,000 or 3,000 being laid by each female.

**Silver Bream** (*Blicca bjoernka*). Sometimes called the white bream, this fish has a larger eye than the common bream : his mouth is lower down (not at the end of the snout, as in the bream) and a rather more silvery colour. He is a less lively and sporting fish. Fins reddish or orange. Otherwise very like the common bream in form and ways of life.

**Bleak** (*Alburnus lucidus*). This pretty and lively little fish looks more like the dace than the bream, being slim and silvery, though actually he is a very close relative of the bream, being much more distantly related to the dace. Bleak are rarely more than half the size of dace, an 8-inch bleak being considered a fine specimen. Bleak have blue-black and silvery sides, and live in shoals in still or very slowly flowing water. They spend a good deal of their time on the surface, leaping for flies, feeding on worms, crustacea and insect-larvae. Eggs are laid from April to June, in shallow water, and cling in lumps to stones or water-plants.

## LOACH FAMILY

(*Cobitidae*)

This family is closely related to the carp. They are mostly small bottom-haunting fish of sluggish habit. Only two members are found in Britain.

[1] J. H. R. Bazley, *The Art of Coarse Fishing*, p. 127.

**Stone Loach** (*Nemachilus barbatula*). About five inches long. Has the body spotted or marbled, and the fins crossed by series of small spots. Six barbels. Found in small streams.

**Spined Barbel** (*Cobitis toenia*). Takes name from a spine that lies in a groove below each eye. Often lies buried in the sand with head sticking out. Rarely more than four inches long.

## PIKE FAMILY

(*Esocidae*)

"The pike is by far the largest of the coarse fish. . . . Not only is he the king of the river and lake in the sense that every other fish fears him, but he has his own place in the economy of nature. It is in the order of things that when he is seeking his prey, the weakest and less speedy should fall victims to him, and in this way the species of fish upon which he lives become denuded of their weaklings."[1] Feeding for the most part on small fishes, pike can swallow a salmon their own size, and are often prompted by hunger to bid for higher game, such as frogs, ducks, geese, water-hens and water-rats. This great fish, olive-grey above, silvery white on the belly, mottled with pale spots or yellow wavy bands on the sides, and with dorsal, anal and caudal fins having dark spots or stripes, may sometimes attain a length of four feet and a weight of 60 pounds. His large mouth appears to split his face in two, and is lined with strong teeth, giving him a savage appearance. He has long sharp teeth in front intended to grab and hold rather than to cut and masticate. He has hundreds of smaller ones on the roof and back parts of his mouth, which are hinged and bend backwards to help the passage of a fish down the throat—and prevent the escape of the victim. Pike of three years old and over as a rule lead a solitary life ; and they

[1] J. H. R. Bazley, *The Art of Coarse Fishing*, p. 154.

live in fear of being devoured by their own kith and kin! In spite of this, pike are long-livers, and those lucky enough to live out their full natural life may attain to an age of three score years and ten. Very few are as lucky as that. In early spring, these great solitary monsters gather together and make their way into ditches and backwaters where their eggs are laid among the weeds. One female pike may lay half a million eggs or more. The young hatch in about three weeks, remaining near the surface for some ten days until the yolk-sac is absorbed, when they make for the depths in search of food. It is at these tender ages that most pike have their life cut short by their thousand and one enemies.

The common pike (*Esox lucius*) is the only member of his family to be found in British waters.

## PERCH FAMILY

(*Percidae*)

**Perch** (*Perca fluviatilis*). With black stripes flanking his broad, hog-shaped, olive-green back, with double dorsal fin erect, and bright red anal and pectoral fins extended from his white belly, with his golden sides a-glitter, the perch looks the part of the bold adventurer. "He is one of the fishes of prey that, like the pike and trout, carries his teeth in his mouth, which is very large; and he dare venture to kill and devour several other kinds of fish." (Izaak Walton, Part I, Chapter XII.) Perch rove in shoals in search of little fishes, worms, insects, larvae, shell-fish. They breed in reedy shallows from March till May, the eggs being laid in long strings, like necklaces, usually stuck on to water-weeds. Perch may reach a length of a foot and a half.

**Pope or Ruffe** (*Acerina cernua*). A smaller fish than the perch, the pope or ruffe has the dorsal fins joined, and the back and sides darkly spotted.

## SALMON FAMILY

(*Salmonidae*)

Several of the fish we have mentioned—the perch and the bream, for example—are sea fish that come to the rivers to breed, and may spend weeks or even months in the inland waters, and so are entitled to be called freshwater fish. There are a few other kinds, such as sturgeon, that are sea fish, occasionally to be found in our streams and rivers.

We have already, in Book One, Chapter VII, looked at two of the most important freshwater species that spend a great deal of their life at sea, and there now remains for us to glance at the further members of the salmon family.

**Trout.** There is only one species of trout in the British Isles, though there are two varieties, the sea trout (*Salmo trutta*) and the brown trout (*Salmo fario*). The brown trout are simply sea trout that have lost the habit of going down to the sea. Now and then, however, they have been known to go down to the river estuaries and occasionally they have actually been caught at sea.

There are probably no fish that vary so greatly in appearance as trout. They vary in size, shape, and colour, according to the food they eat, to the temperature of the water, to the sort of river-bed over which they swim, etc., and these variations result in a number of local names given to the trout. In general, however, the trout is very like the salmon, but with a larger mouth, a larger eye, and a larger head in proportion to the body. The tail of trout is not forked, as is the tail of the salmon, and trout as a rule are marked with deeper colour and larger spots along the back and sides. The colours of the sea trout, which is sometimes known as the salmon-trout, are brown upon the back, silvery-blue sides, pink beneath ; but these colours, as we have said, vary greatly. The brown trout tends to be brown on the back and yellow on the belly, with a tinge of green on the sides. Sea trout are the most active and sporting of the *Salmonidae*. They swim up a river much faster than do

salmon and can get up to shallower water. They swim in a zig-zag fashion, while salmon usually swim straight.

Trout are often earlier than salmon in the same river, for the purpose of laying their eggs. Their methods are very like those of the salmon, which we described in Book One, Chapter VII. The eggs are laid on a gravel bed in a shallow river or brook, in autumn or early winter—generally in October or November, sometimes as late as January. The eggs will be about the size of peas if the mother is a big, healthy fish. As the eggs sink from the mother a fertilising liquid comes from the father fish, but may fertilise only a few of the eggs. The parent fish then sweep gravel over the eggs with their tails, but so carelessly that often many of the eggs remain uncovered.

Unlike salmon, trout feed in fresh water, and so remain vigorous and may go down to enter the sea as strong and healthy as when they left it. " Smaller trout generally move about in little parties of five or six ; when resting on the river-bed they lie in sections facing upstream, in order of size, the heaviest at the top and the smaller ones below in arithmetical progression. There appears to be an unwritten law that each fish has his own beat and woe betide an outsider who happens to be smaller and tries to encroach on it. When one is caught or killed the next one in order below him takes his ' pitch.' Old trout become rather solitary, and do not join a shoal ; they usually occupy a good pitch and stick to it for the season, keeping all others away."[1]

**Grayling** (*Thymallus thymallus*). This beautiful trout-like fish can be at once recognised by the very large dorsal fin gaily banded by rows of green and purple spots. Grayling have smaller mouths and teeth than trout : their backs and sides are silvery grey with darker bands running along the fish from head to tail. Egg-laying in April and May.

Among other fish which may be found in British waters, we may mention the so-called **Brook Trout** (*Salvelinus fontinalis*) which is a char that has been introduced into

[1] G. W. Maunsell, *The Fisherman's Vade Mecum*, p. 453.

British streams from Canada and United States. **Rainbow Trout** (*Salmo iridens*) is a member of the *Salmonidae*, native to America, which has been introduced into a few British rivers. Of the Lamprey family (*Petromyzonidae*), **River Lamprey** (*Lampetra fluviatilis*) and **Brook Lamprey** (*Lampetra planen*) are small fishes, the former going sometimes to sea, while the **Sea Lamprey** (*Petromyzon marinus*) comes up rivers only to breed. We have mentioned that a fish with similar habits, the sturgeon, is found in several British rivers. This is a very curious fish, belonging to an ancient, primitive family, the *Acipenseridae*. Does not breed in British waters. In certain northern rivers and lochs the **Smelt** (*Osmerus eperlanus*), of the family *Osmeridae*, is found, whilst in certain southern rivers, the shads, **Allis Shad** (*Alosa alosa*) and **Twaite Shad** (*Alosa finta*), which may grow to be two feet long, are not rare. There is one member of the cod family, the *Gadidae*, which is a freshwater fish. This fish, the **Burbot** (*Lota lota*), is found in the eastern rivers from Durham to Suffolk. In the family *Cottidae* is found one quite common fish, which we must briefly describe. **Bullhead,** sometimes called **Miller's Thumb** (*Cottus gobio*), is a fish 3 or 4 inches in length, with a scaleless body and a broad head, from each side of which a rather strong spine projects. His olive-coloured body may be spotted or barred with brown or black. Bullheads lurk on the bottom or under stones, waiting for the young fishes, worms, etc., on which they feed. In March or April they scoop out a hole under a stone, thus making a nest in which they lay the eggs, which stick on to the under-side of the stone. The father guards the nest until the fry swim away, which reminds us of father stickleback, whom we described in Book One, Chapter IV. There, we may remember, we pointed out that there are many species and varieties of stickleback, not a few of them being freshwater fish. The common " tiddler " of canals, ponds, lakes and rivers is one of these. The sticklebacks belong to the family called *Gastrosteidae*.

# CHAPTER III

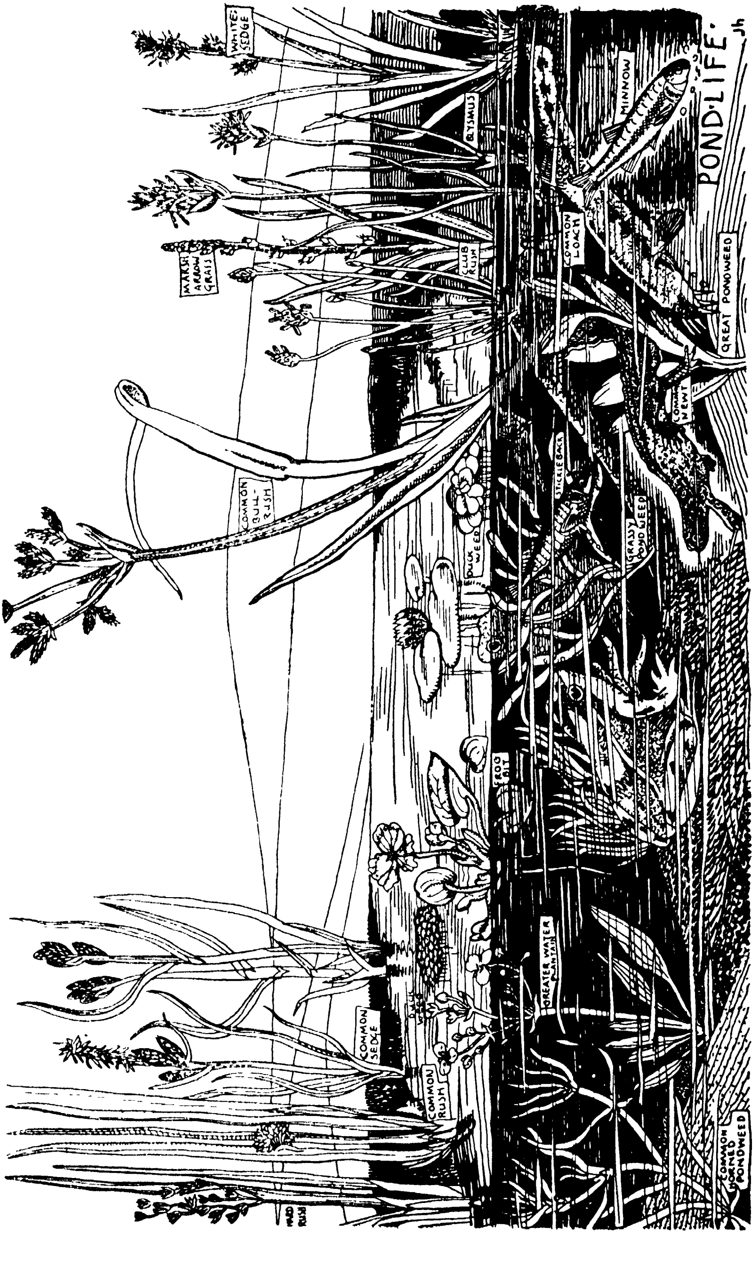
# REPTILES, AMPHIBIANS AND SOME LOWLY CREATURES OF THE INLAND WATERS

WE HAVE SPOKEN of the food of fishes, of the molluscs and crustaceans of the rivers, streams and ponds ; and we must devote a chapter to some few of the swarming multitude of small but interesting forms of life that cluster upon the banks of these inland waters. We might as well begin with a creature that is very numerous, although his reputation is by no means enviable—the leech.

Leeches possess a beauty all their own. Most of them are marked in concealing colours and patterns, browns, greens and blacks, which copy the broken shadows of the stream-bed and the forms and hues of water-weeds against which they live. They are sensitive to the slightest shaking of the water, and to shadows passing over them. They live by sucking the blood of molluscs, worms, insect larvae, and even of vertebrate (backboned) animals : a leech may at one time be found feeding on snails or insect-larvae, and next meal he may be clamped to the body of a frog, lustily sucking the frog's blood.

Leeches are segmented worms, like bristleworms and common earthworms, and they belong to the phylum *Annelida*. The leeches of the family *Hirudinidae* are those most often found in our ponds and streams. They are nearly all aquatic : only a few live on land.

The horse leech (*Haemopsis marmoratis*) lives in the mud by the sides of pools, ditches and streams, feeding on


POND·LIFE·
WHITE SEDGE
MARSH ARROW GRASS
BLYSMUS
MINNOW
COMMON LOACH
CLUB RUSH
GREAT PONDWEED
COMMON NEWT
STICKLEBACK
GRASSY POND WEED
COMMON BULL-RUSH
DUCK WEED
FROG BIT
GREATER WATER PLANTAIN
COMMON SEDGE
COMMON RUSH
COMMON HORNED PONDWEED

aquatic worms and molluscs. Whenever he has a chance he will suck blood from the legs of wading animals. All leeches will suck blood ; but we should not abhor them for their taste, and may remember they have often been used for medicinal purposes, and still are in many places. When not feeding they prefer to rest attached by their suckers to the under-sides of stones, half-buried in the mud. They have the strong muscular suckers at each end of their bodies. They reproduce their kind after the manner of earthworms, fertilising each other ; and they lay eggs which lie snugly in a horny case like a cocoon. In certain families the cocoon is carried about by the mother, and when the family hatches out, the leechlets cling to their mother by their back suckers, with their heads hanging free, and are carried about by her until they can fend for themselves.

Before passing on to higher forms of life beside the stream, we should give a thought to that phylum *Mollusca* with which we introduced the scientific grouping of animals.[1] We learned that there are about 60,000 species of mollusc in the world ; and we should now note that at least one-fifth of this number live in fresh water. Nearly all these freshwater inhabitants are either of the snail class, or are bivalves, such as mussels.

Freshwater snails can be distinguished from land snails by the fact that they have two outstanding tentacles with a small black eye at the base of each, while land snails have four tentacles. They are very similar in appearance and habit to our winkle (Book One, Chapter I). The freshwater snails breathe partly by lungs, partly by gills.

Of the crustaceans (phylum *Arthropoda*) of our inland waters, the smallest are freshwater fleas and cyclops ; and they range in considerable variety and numbers up to the freshwater crayfish, very common in many of our rivers, especially those in chalky and limestone districts. The crayfish, who more nearly resembles a lobster than anything else on earth, is not, of course, truly a fish.

[1] Book One, Chapter I, conclusion. See also illustration on p. 22.

We remember in Book One dealing with the seashore species of these molluscs and crustacea, in which we gave a fairly full account of their body-structure and ways of life. The freshwater species of these creatures have evolved directly from the shore specimens, merely adapting themselves to the quieter conditions and to the different type of water. We remember, too, in Book One, remarking that the seashore was the " cradle of life," in the beginning of evolution ; and showing how, first one type and then another kind of creature, crept out of the watery cradle upon the dry land. We instanced winkles and other amphibious species as being forms of life half-way between sea creatures and land creatures ; but we took care to note that such species were not true amphibians, which are included in the special class *Amphibia* in the phylum *Chordata*. Amphibia is known to some scientists as *Batrachia*, an old name which is now very little used.

The amphibia were the first animals to escape from life under water, clambering from a fish's life to the life of a dry land animal. But they did things by half. To this day amphibians have to go and lay their eggs in ponds and streams—grey jelly-like masses of eggs ; and these eggs hatch out into the tiny fish we term tadpoles. The name tadpole was originally " toad-poll," meaning a toad with a big " poll," or head.

The little tadpole-fish has gills and is in every sense a creature of the class *Pisces*. Then his head swells, and tiny limbs sprout from his sides : he gradually develops lungs, and hops out on to the muddy, reedy bank beside the water. His gills disappear and his long tail grows into him, becoming absorbed into the body of the perfect land toad.

All creatures of the class Amphibia—such as toads, frogs and newts—live this double life : they live at one time under the water as fish and at another time as land animals. We have seen already in this book that there are other creatures whose development follows the sequence of amphibians, though they are not classed with them. We


remember that the larva of the dragonfly lives under water until the wings develop, in the same way that the tadpole of the frog lives under water until the legs develop.

In so far as the growth of the young are concerned, the main difference between amphibians and reptiles is this : amphibians have a fish-like youth, freely swimming as fishes in ponds and streams ; reptiles get through their fish stage while they are still in the egg, and they emerge from the egg as perfect little reptiles ; and so reptiles do not have to lay their eggs in water. They make their nests on land, as birds do. Reptiles, therefore, can be said to have conquered the land completely. They were the first animals to do so ; and anyone who has read about the prehistoric age of giant reptiles will not need to be told that this class of creature was once king of the dry land.

All the higher classes of land creature in time evolved, by perpetual adaptations, from the primitive amphibians and reptiles. Birds are descended from reptiles. So are the

mammals. All these creatures go through the stages of their ancestry before they attain the final perfect form of their kind. Mammals do so in the body of their mother, not in an egg, but in a sort of nest of flesh within the mother's body, in the uterus, or womb. We ourselves, as human beings and mammals, were first formed in fish, amphibious and reptile form ; and we changed through these forms into our present form without having the freedom in pond and stream enjoyed by toads in their tadpole stage.

This is perhaps the most interesting, mysterious and beautiful aspect of the life of those amphibians and reptiles which we can find beside the village stream or lurking in the long grass of wet meadows. They are creatures left over from a time when their kind was king of the " dry land," and they are linked to us in our present history and our past history in the web of life.

To return to the toads. The true toads are but one out of 100 species that constitute the class *Bufonidae* (true toads). These animals are distinguished from their very near relatives the frogs (family *Ranidae*) by their stouter build, their rougher, wartier skins and their toothless jaws. There are two species common to the British Isles, the common toad (*Bufo vulgaris*) and a less widely distributed variety called the natterjack, who has a yellow line down his back, and legs so short that he cannot hop like the rest of the species, but must run.

Toads lay their eggs in long strings, forming double lines of straight jelly-like tubes. The eggs hatch in the same way and the tadpoles undergo the same changes as those of frogs. The chief difference between frogs and toads is that frogs have slenderer bodies and smoother skins, otherwise they are very much alike in having relatively short stout bodies, very short necks, extremely long hind limbs, and no tail. The nose or snout is long and rather pointed, they have large, well developed and prominent eyes and just behind the eyes can be seen a circular patch which indicates the position of the ear. Frogs and toads are the most highly developed of the amphibians. Newts, another

group of this class, have small or no eyes and are deaf and dumb (and as all of us who have lived near a frog-inhabited pond are aware, frogs and toads make the most of their vocal organs). The fore limbs of frogs and toads are short, and have four fingers, with a very long third finger, whilst the hind limbs are very long and powerful (except in a few species). On their hind limbs their feet are webbed, with five long toes. The skin of these creatures is moist, and is kept in its shiny condition, when they are away from water, by glands under the skin which secrete mucus. Frogs have very large mouths, with small closely set teeth. The long, sticky and deeply cleft tongue darts swiftly out to capture the small insects, flies, caterpillars, spiders and earthworms which form their chief food. Frogs never chew, they swallow their victims in great gulps. If the food is too large to be snapped in a mouthful, then the frog seizes it in his hands and stuffs the creature into his mouth, like a greedy child eating cream cakes, his eyes almost disappearing into his head with the effort.

In summer frogs and toads live in damp, cool grass, leaping in search of food (except the natterjack, who runs) ; but in winter they retire into the mud at the bottom of ponds and ditches and pass the months until spring in a state of torpor or *hibernation*. At the first approach of spring they leave these dull winter quarters and congregate in immense quantities in the water. Mating takes place (the males at this season develop a tendency to sing, and croak both in and out of water) and the small black eggs are laid, as many as five thousand in a clutch.[1] The adult frogs then leave the water and resume their life on land, and the males lose their desire to croak.

When they have been in the water for a few days, for a week if the temperature is low, the eggs hatch, and tiny black tadpoles emerge, to cling in crowds with the tips of their snouts to any convenient object. They are curious little creatures, with a head and body in one rounded mass,

[1] " Clutch " is the name given to the eggs laid at one time by birds and amphibians.

in which a pair of eyes and a small mouth with a pair of horny beak-like jaws can be seen, the whole propelled by a long tail. The jaws contain even rows of minute horny teeth which rasp the food, green slime and dead vegetable matter.

Very rapidly the tadpole grows, and soon rudimentary hind limbs appear. The tadpole frequently swims to the surface of the water to breathe, which shows that lungs are developing. Then the front limbs appear. Slowly the creature becomes more frog-like, and still with a remnant of a tail, the miniature frog leaves his water-nursery to start his life on land.

There is one more order of amphibians which we must glance at before we pass on from these half-land and half-water animals and that is the order *Caudata*, the group which is represented in our land by newts. Newts are small lizard-like animals with short limbs, having four clawless fingers and five similar toes. There are over twenty species, the British kinds including the crested newt (*Molge cristatus*) which grows to a length of four and a half inches, has a wrinkled skin covered with warts, and a high crest running along its spine. The upper parts are dark with black spots, the sides are speckled with white, and the lower parts are yellow or orange, spotted or marbled with black. A silvery stripe adorns the side of the tail in the male. The common newts (*Molge vulgaris*) and the palmated newts (*Molge palmata*) are smaller animals, two and a half to four inches in length, with smooth skin and mottled markings.

Newts spend the summer months on land, concealed in damp places ; under stones, or logs of wood, or in holes. They venture out at night or in wet weather in search of food, earthworms or slugs. They hibernate in winter in cool hollows, but at the first call of spring they wake up and repair to the water to breed. During the winter months, the male has developed a higher and more prominent crest, and becomes more brilliantly coloured, a state which lasts through spring and early summer. The eggs are laid singly or in bunches of two or three attached to the leaves of

water plants, whose edges are folded over and stuck together by a gummy secretion which protects the eggs. About a fortnight later the tadpoles, each provided with three pairs of feathery gills, emerge and attach themselves for a few days to water plants. Then they become active, and swim about vigorously, feeding on larvae, insects and small crustaceans. Slowly the limbs develop and late in the summer the tadpoles metamorphose, losing their gills, developing eyelids, and are ready to leave the water and live on land.

And now we must leave Amphibians, and take another step along the road that leads from fish to man.

Millions of years ago, in the Permian Age, the reptilian class, which was dominant among vertebrates, branched out into many orders, one of which included the ancestors of the mammalia, and another from which birds and crocodiles arose. Turtles and tortoises are the descendants of another early group, and snakes and lizards are a comparatively recent development.

The forms which exist to-day are grouped into four classes, *Crocodilia* which includes crocodiles and alligators, *Squamata* which includes lizards and snakes, *Chelonia* the turtles and tortoises, and *Rhynchocephalia* which is represented by one single species, the Tuatera lizard, of New Zealand. Of these, we shall concern ourselves with *Squamata* and *Chelonia*.

There are more than 2,000 forms of snake at present known, so that snakes and lizards have equal claim to dominance in the reptile world. Snakes are differentiated from lizards by a few relatively trivial points, absence of limbs, no movable eyelids or visible outside ears. Yet some lizards are limbless, and some snakes have hooks where their hind limbs would be. Their eyes are protected by a transparent covering much as the face of a watch is protected by the glass. Snakes have very keen eyesight, but their chief sense organ is the tongue, which is very long, slender and forked, and can be withdrawn into a sheath at its base. This very sensitive organ determines for the snake

the nature of most things. All snakes are carnivorous, and most of them can swallow a victim three times their own size. They can do this because the jaw of the snake is not held together by the bones, but by elastic ligaments, so that the two halves of the jaw can be pushed widely apart to enlarge the mouth. Snakes have curved, pointed teeth, with several reserve rows in various stages of development, and if any get broken off during the victim's struggle, these spare teeth move up to take their place and become one with the jaw-bone. Some teeth are modified as fangs, to which the venom, pale straw-coloured liquid manufactured by a special gland behind the angle of the mouth, is transmitted by a tube which opens near their base.

Although some snakes attack without being provoked, they are mostly timid and secretive. All snakes have skins covered with scales, and periodically these skins are cast, a process known as " sloughing." This starts at the lips, and by vigorous rubbing the old skin is turned back on itself, the snake gradually works its way out, and the old skin is left inside out. Snakes lay eggs, in places where they will be hatched in moist heat, otherwise they are left generally to take care of themselves. These reptiles have adapted themselves to varying climatic conditions all over the world, but only two families are represented in Britain, grass snakes and smooth snakes (*Colubridae*), and adders (*Viperidae*).

The adder (*Vipera berus*), common in England, is the only poisonous British snake, and may be distinguished by the upright egg-shaped pupil of its eye, and the absence of enlarged scales on its head. Its colour varies, being grey, brown-reddish, or entirely black. Its bite is painful, but rarely fatal. The common English grass snake, a water-loving reptile, is also very variable in its colour pattern, being usually greyish-green with black markings, and traces of orange or yellow round its neck. It dwells in damp and marshy places, lives entirely on frogs, and is an excellent swimmer. The English smooth snake lives entirely on sand-lizards, so is only found in localities where these


lizards also occur. It must not be confused with the adder, the difference being smooth scales, a round pupil, and enlarged scales on the top of its head.

There are 2,500 species of lizard known in the world to-day. There are water lizards, flying lizards and land lizards, including those that burrow for a living beneath the soil. Some form of lizard is found in every country in the world except those lands where the sub-soil remains frozen throughout the year, such as the North-West Territories of Canada, Northern Scandinavia, and Siberia.

The skin of lizards is covered with a layer of horny scales of great variety. Like the skins of snakes this is shed periodically. The burrowing groups have almost lost their limbs—limbs being a nuisance in underground tunnels, biting jaws being the best means of burrowing. The tails of lizards can be cast off at will, like the legs of shrimps and prawns and the claws of crabs ; and in the same way they can be re-grown. Sometimes, indeed, cautious lizards grow

two or three tails, just in case one gets hurt. The tail is used as a weapon of defence. Unlike the snakes, the lizards have eyelids which they close in sleep.

The common lizard (*Lacerta vivipara*) is five to seven inches in length, grey or brown in colour along the back, orange or red, spotted with black, underneath. The four limbs of the lizard foreshadow the body of the mammal. Each bears a well-formed hand or foot, with five long slender fingers. Each finger carries a curved claw.

As his Latin name indicates—*vivipara*—the common lizard belongs to the kind of creature who carries her eggs inside her until they hatch, and her young come forth from her body able to fend for themselves. This is not the case with all lizards. Many of them lay their eggs and leave them in the sun to hatch.

The so-called slow-worm or blind-worm (*Anguis fragilis*) is neither slow nor blind, nor is it a worm. It is a lizard that has no limbs, though there are traces of limbs to be found inside the creature. The slow-worm is fairly common in Great Britain and lives in ditches and among bushes, coming out at night in search of earthworms and slugs. Young slow-worms are whitish above with a black stripe running down the middle, and black on the sides and below. The older slow-worms tend to be brownish above. About one foot long, the tail takes up half that length. The long, pointed jaws are set with backward-slanting teeth, and the small—but by no means blind—eyes have movable scaly eyelids.

Slow-worms are often mistaken for snakes, and are much feared by country people in many districts ; but they are perfectly harmless reptiles that have never done injury to anything larger than an earthworm or a slug. So timid are they that they become rigid with fear when caught, and if you try to bend their snake-like bodies when they are frightened they will break like sticks because their muscles are held so taut. It is for this reason that they are called *fragilis*. Yet in their normal movements they coil through tufts upon a grassy bank with as many twists as a snake.

# CHAPTER IV

# WHAT IS A BIRD?

BIRDS, we have said, are descended from reptiles.

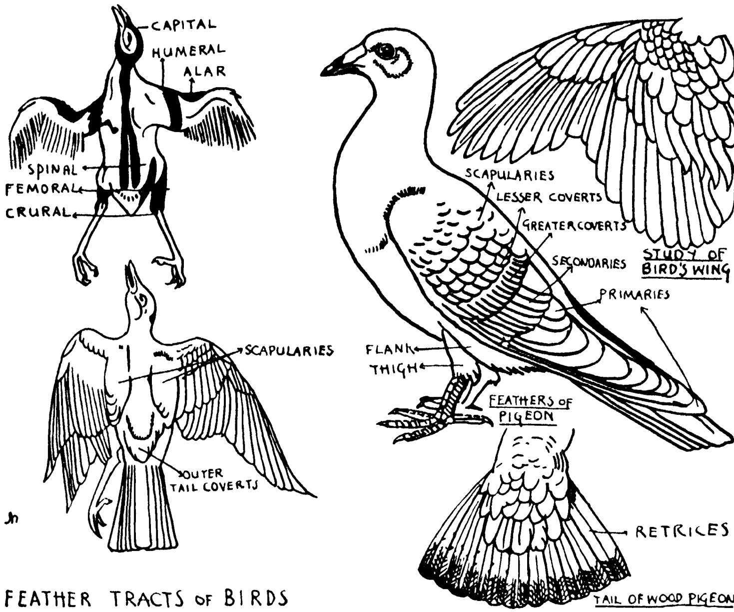
At first sight it seems absurd to attempt to draw any likeness between the active, feathered, hot-blooded birds, and the sluggish, scaly, cold-blooded reptiles.

In no bird are there scales upon any part of the body, except the legs. But *in all birds the legs are scaly.* And the feathers which cover the rest of the bird's body have *evolved from scales.*

Feathers are not " adapted scales," but were in the beginning outgrowths upon scales. The scales have disappeared from the bodies of birds, and these outgrowths have been perfected into feathers.

Reptiles and fishes are cold-blooded creatures because scales do not keep them warm. Because they cannot keep warm, reptiles and fishes take their temperature from the medium in which they exist—that is to say, fishes are little, if any, warmer than the seas in which they live. In the open air, where reptiles live, heat and cold reach greater extremes more rapidly than under the sea, and so most reptiles have to remain natives of warm climates, and would die of cold if they migrated to temperate climes. But their wonderful downy coating of feathers has made birds independent of climate in a large degree.

Perhaps the most interesting of all features in a bird are the feathers and wings. " The examination of any bird will show that it has several kinds of feathers. They are all constructed upon the same plan, but some are larger than others, and the smallest are soft instead of firm to the touch.




The biggest set of all is a set which fringes the wing and another set at the end of the tail. These are called respectively the 'remiges' and 'rectrices,' or the 'rowing' feathers and the 'steering' feathers. Their principal use, as may be imagined, is in flight. The remaining feathers are also to some extent used in flight, but their main use appears to be to keep the body warm. An eider-down quilt, as everybody knows, is the warmest kind of coverlet ; the reason being that feathers are very bad conductors of heat, and do not, therefore, allow the heat of the body to escape. Birds are the hottest of all animals, which is in part due to their covering of feathers."

Birds "moult" their feathers once a year—as a rule, in the autumn. Moulting is simply the dying off of old feathers, after which new feathers are grown. Some birds moult twice a year, putting on a special summer plumage ; but once a year, in the autumn, is the rule.

When we come to wings, the evolution from reptilian

life is quite as evident. The wings of birds are the fore-limbs of reptiles adapted from use for climbing to use for flight. The wing of a bird, indeed, is not unlike a short arm with a big feather-covered hand. " We can easily recognise the same bones, though they are less in number and often of a different form . . . the bird . . . has three fairly well-developed fingers, or rather two well-developed and one less perfect. The shortest finger corresponds to the thumb of our hand. It is more freely movable than the others. It might be supposed that the hand of the bird had no nails or claws, but this is not the case : every bird has at least two nails, of a long and rather claw-like form when well developed, and sometimes three nails, that is, one to each of its fingers. It looks, therefore, very much as if the wing of the bird had been formed out of a limb that was once an organ for climbing or walking with. There is a curious bird, found in British Guiana, which is known as the hoatzin. In the very young nestlings of the hoatzin the claws of the fingers are so conspicuous that they are actually used by the chick to climb with, before the feathers of the wings have grown sufficiently to enable them to use their wings in the proper way in which a bird should ; it has been said also, that other birds scramble about and use their claws when very young."[1]

The brain of birds is large in proportion to the body, thus contrasting with that of the unintelligent brains of the reptiles from which birds sprang. If weight of brain means anything, the goldfinch is one of the most intelligent of birds, and the most stupid is the domestic fowl.[2]

But we speak of " birds," thus lumping together the savage condor, whose body may be five feet long, whose outstretched wings have a span of more than twice the body-length, who gorges his great body upon the carcasses of the jungle and may eat as much as 20 pounds of meat in

[1] Frank E. Beddard, " Anatomy of a Bird," in W. H. Hudson's *British Birds*.

[2] The raven, however, has the reputation of being the most intelligent of all birds.

a single day—we lump this creature with the little lark who rises with a shower of musical notes towards the dome of heaven. Swift flyers like the swallows we connect with creatures such as the penguins who can outswim the fishes of the Antarctic Ocean, though they can never fly in the air . . . all these, and so many thousands more, of so many varying shapes, sizes and ways of life, we group into the great class " Aves " within phylum Chordata.

In the famous library of Assurbanipal, King of Babylon,[1] there have been found inscribed baked clay tablets showing that the ancient Assyrians had some knowledge of natural history, and a rough classification of animals. Birds, for instance, were divided into classes, such as :

Sea-birds,
Marshland birds,
Swift-flying birds, etc.

Nowadays the birds, like the insects, the plants, the fishes, the mammals and reptiles and all forms of living creatures, are grouped according to their known relationships.

At the present time there are about 25,000 different species of bird living in the world. These are grouped by scientists into orders, families, genera and species, in the same way that the other divisions of the world of nature are grouped.

## ORDERS AND FAMILIES OF THE BIRDS

**Struthioniformes.** The order of the ostriches, all of whom are placed in a single species with five *subspecies*. Natives of Africa and the Near East, they are the largest of all living birds. They are flightless, but can run with great speed. " When the ostrich skims along the surface of the

[1] He lived in the seventh century before Christ. It is thought he died 626 B.C.

sandy deserts where it is often found, it holds out both wings, which are compared to sails ; they possibly serve rather as the pole of a tight-rope walker, to preserve the balance of the bird when hurrying along at full speed." Ostriches have only two toes on each foot.

**Rheiformes.** The order of the rheas, or American ostriches, flightless birds of smaller size, native to South America. They have three toes and differ in several other ways from true ostriches. There are three species.

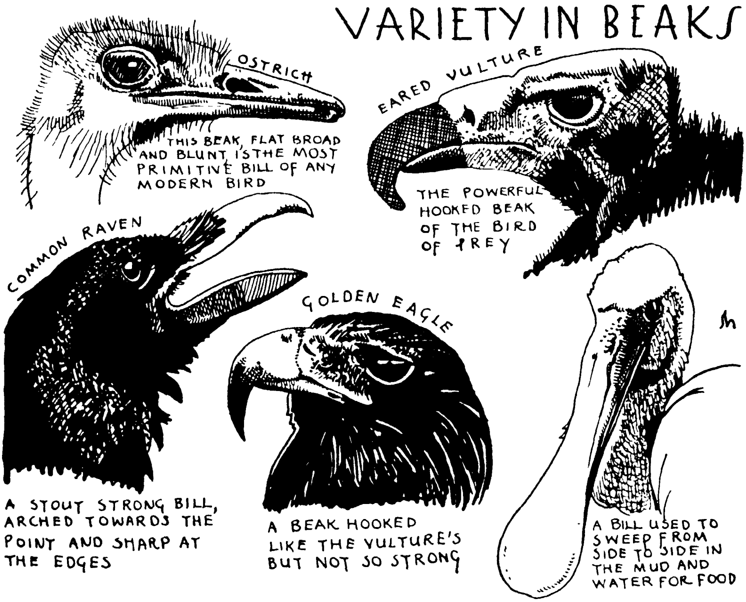
**Casuariiformes.** The order of the cassowaries and emus, which are also large flightless birds, native to Australasia. The cassowary family has sixteen species within several genera. There is only one species of emu.

**Apterygiformes.** The order of the kiwis, the peculiar flightless birds of New Zealand. They are about the size of domestic fowl, their bodies are covered with bristly feathers that resemble hairs, they are nocturnal and feed chiefly upon earthworms.

**Tinamiformes.** A South American order of birds which resemble quail and grouse but are related to all the flightless orders. The tinamous, however, can fly, though they do so about as rarely as do cocks and hens in our backyard.

**Sphenisciformes.** The order of the Antarctic penguins. There are more than twenty species, one kind dwelling as far north as the Galapagos Islands, but most of them within the Antarctic circle. In many ways the penguins are the most odd and primitive of living birds. As we have noted, they cannot fly, but can outswim small fish under water. Their feathers are almost scale-like and lie flattened against every inch of the body. The birds stand as upright as men on their flat webbed feet.

**Colymbiformes.** The loons, or divers, and grebes. See Book One, Chapter V, for some account of the great




northern diver. There are five distinct species of loon. The grebes are smaller than the divers, and whereas divers have webbed feet, the grebes have divided toes.

**Procellariiformes.** Albatrosses, shearwaters, petrels, fulmars and other deep sea birds, a few of which we examined in Book One, Chapter V.

**Ciconiformes.** Pelicans, boobies, cormorants, gannets, herons, storks, ibises, flamingoes, shoebills, snakebirds, frigate birds, etc. A large order, mostly of long-legged birds. Some scientists divide them into two orders, calling one order *Pelicaniformes* and grouping the pelicans, boobies, cormorants, snakebirds and frigate birds apart from the rest.

**Anseriformes.** The order of the ducks, geese and swans. Ducks and geese are abundant throughout the world. There

are about 65 or 70 species of river duck, the best known being the common mallard (*Anas boschas*) of the sea ducks, perhaps 50 or 60 species are known widely distributed in all parts of the world. There are a great number of domesticated species bred from the wild forms, mostly from the river ducks, which generally have more tender flesh and are better eating. (For sea ducks, see Book One, Chapter V.)

There are about 40 species of goose. They walk better than ducks, the legs not being set so far back on their bodies. There are many domesticated kinds.

There are about 10 species of swan, and whereas ducks and geese increase and multiply and replenish the earth, the swans have rather a struggle to keep up their numbers, and in many parts of the world they are protected and cared for by men on account of their ornamental beauty.

**Falconiformes.** The order of the chief birds of prey, the vultures, hawks, falcons (eagles, etc.), the kites, condors and others.

Most of us see little or nothing of eagles nowadays though they dwell in the mountainous regions of Scotland and Ireland, and there are a few in the higher lands of England.

**Galliformes.** This is perhaps the most important bird order, from man's point of view, since it includes the common domestic fowls, who deliver us our daily egg (who are descended from the jungle fowl of India), as well as Christmas turkeys, and grouse, quail, pheasants, guinea fowls, partridges and others.

**Gruiformes.** The order of the cranes, rails, bustards, etc. An interesting point of difference between herons and cranes is that, although both are long-legged and long-necked, the herons when flying curl the long neck in an S-shape with the head drawn back near the shoulders, but the cranes and rails hold it stretched out in front in flight, like wild duck.

**Charadriiformes.** Pigeons, plovers, sand-grouse, sandpipers, oyster-catchers, gulls, terns, skimmers, auks, puffins, etc. We have already glanced at gulls, puffins, oyster-catchers and one or two more members of this order in the chapter called " Sea-Birds." They are popularly grouped under the term " Shore Birds," though some species—pigeons, for example—are decidedly land birds. We should say here that some scientists group the pigeons into a separate order, *Columbiformes* ; and we should note that from the earliest ages man has made friends with the pigeon family, and has bred many varieties of beautiful forms of dove from the wild " rock dove," who is the original parent of the pigeons.

And last, but not least, there are the three orders **Cuculiformes,** the order of the cuckoos and parrots, **Coraciiformes,** the order of the owls and kingfishers, of the humming birds, swifts and woodpeckers, etc. **Passeriformes,** the order of the sparrow, robin, jay, wren, lark, swallow, crow, finch, etc. Nearly half the birds known to mankind are included in the perching group (order *Passeriformes*). This includes 70 families, grouped into four sub-orders. The species in this order are mostly small, the crows and ravens being the largest. The possession of a sweet singing voice, such as those of the larks, nightingales and canaries, is limited to birds within this order.

## CHAPTER V

# THE WEB OF LIFE: THE MYSTERY OF BIRD MIGRATION

ONE OF THE GREAT CONTRIBUTIONS made by Charles Darwin to our understanding of nature was the idea of "the web of life"—that is, the idea that every living thing is in some way connected up with every other living thing. In his book we have seen that all living things may be connected up *historically* : the history of all animals may go back to one-celled sea-forms, the history of all plants may go back to the ancestors of the diatoms, and these first plants and first animals are linked up in the first of all living things that strived in the dead seas of our most ancient world.

We have glanced at a few ways in which all living things are linked up to-day. We have glanced at the food-chains and at the "balance of nature" by which one species provides the food for another and a pattern of eaters and eaten is woven over the earth. Creatures are also linked in many other ways, though we have had space to peep at but a few. We have chiefly concerned ourselves with the linkage between plants and insects, whereby these types of life, so different, are yet seen to support each other, with a strange perfection.

Plants and insects of all kinds are also linked up in countless ways with the great community of the birds. Whole species of bird could not exist without certain plants and certain insects, and birds in their turn play their part in aiding plants, and they enter as one of the chief armies into the insect war. There are whole families of birds that live upon insects. . . .

Ants are eaten by many insects, particularly by some of the wood-peckers. Warblers search through foliage for insect prey, seizing it expertly from the twigs and leaves or tumbling pell-mell after some moth that attempts to escape by flight. Aphids are the choice morsels of birds of this type, and smooth caterpillars of various kinds are also prized tidbits. Swallows and swifts plane through the air seizing their winged prey as they fly.

Wherever insects of any kind become abundant, many species of bird turn up to feed upon them. Thus birds aid in keeping down insect pests—though their diet is by no means restricted to this useful menu : they are second only to the insect pests themselves in their attacks upon fruit and grain. There is always argument among farmers as to whether this bird and that is of more harm than good. For instance, blackbirds eat the grubs of many insect pests ; but they also eat the precious orchard fruits. Blue tits eat many harmful insects : they also eat fruit-buds which we can ill afford to lose. Chaffinches eat aphides and insect larvae, but they also eat fruit-buds and sprouting corn. Jackdaws eat the hated leather jackets, grubs and wireworms,[1] but they also eat birds' eggs, and even young birds, to say nothing of grain crops and such vegetables as peas. Rooks eat leather jackets, grubs, slugs and young voles, but they also create havoc by eating newly-sown seeds, young birds and eggs. Starlings eat leather jackets and wireworms, but also fruit and young wheat. Thrushes eat insects and snails, but they, too, eat fruit as well.

Which of these birds is to be accounted a friend of man and which an enemy ?—for each does good in one way, harm in another ! To destroy one of these birds for the fruit or corn he eats is but to increase the number of insect enemies who will harm our crops in other ways. What we lose in the fruit orchard and wheat-field through the work

[1] Wireworms are the larvae of the click beetle (*Eleateridae*, family *Coleoptera*). They are terribly destructive pests who feed on the roots of plants and may live for five years before turning into the perfect insect state.

of the starling, we gain from him in the meadow and garden.

We all know something of bird migration—we have seen flocks of swallows and other migrants setting off to fly south in the autumn and returning to us in the spring. Yet how many of us have stopped to think that certain of these migrant birds are driven to seek warmer climes *because the summer insects of our own land are being killed in myriads by the autumn cold?* Swallows and swifts, cuckoos and nightingales, and many other kinds of bird, live mainly upon insects ; indeed, if there were no mosquitoes there would be no swallows, if there were no midges there would be no swifts, for although these birds eat other insects, mosquitoes and midges are respectively their staple diets.

Such birds migrate in search of insects ! Not all insect-eating birds migrate. Some that eat insects in summer live on seeds in the winter. Nor is the search for insects the only cause of migration ; there are many causes of migration, and not all of them are known.

Various reasons given for bird migration include the belief that the heat of the southern summer is too great for the fledglings, and cooler climes are sought by many species for this reason for breeding. Also, it is thought that many birds prefer the longer daylight of the north during the breeding season. In late May and early June, the height of the nesting season, there are but 12¼ hours of daylight at the equator, there are 14 to 16 hours daylight near the tropic latitudes (cancer and capricorn), there are 18 hours of daylight in the latitude of England, while there are nearly 24 hours in parts of Scandinavia—practically continuous daylight in the Land of the Midnight Sun. Birds love the day, and seek the long sunny days of the north.

Many such reasons, operating together, produce that wonderful movement of masses of birds from one country to another at different seasons of the year. Primitive peoples were wise in noting the movements of birds as portents of the weather and of seasonal and other natural phenomena.

Birds are extraordinarily regular in their migrations. They vary in their comings and goings so little that calendars have been based upon their movements. They may get held up for a week or so by heavy storms—(it is a stirring and suggestive thing to watch a large flock of swallows waiting patiently in the trees whilst thunderous wind streams by them and squalls of rain—to see them waiting patiently for the storm to drop, so that they may rise in a cloudy mass, and take wing for the southlands and the sun)—but they will arrive within a fortnight of their average date.

Their routes, too, are almost as regular as the routes of ocean liners. Most of the migrating birds of Europe, for instance, fly down to Africa for the winter, and three main routes which they follow have been established by bird-watchers.

" *First*, there is the west coast route, which extends from east to west along the southern shores of the Baltic, along the coasts of France and the southern coast of England, southwards to Spain and across to Africa. Among the birds following this path may be mentioned gulls, terns, snipe, oyster-catchers, lapwings, hooded crows, starlings.

" *Second*, there is an Adriatic-Tunisian route. Birds gather in eastern and central Europe, and follow both coasts of the Adriatic to the southern end of Italy, whence they cross the Mediterranean *via* Sicily into Tunisia. This route is followed by many songsters.

" *Third*, there is the Italian-Spanish route. Birds gathering in Hungary, Austria and southern Germany pass to the south of the Alps across the north of Italy, along the valley of the river Po. Thence some may follow the coast of France and Spain to Gibraltar, while others cross by Corsica and Sardinia, or *via* the Balearic Isles. This route is followed by thrushes, starlings, plover, swallows and many other birds."

Such itineraries look like tours arranged by Thomas Cook ! A few odd birds have routes that certainly look like specially-conducted round trips arranged by some shipping

company. The golden-plover, for instance, breeds in the Arctic, and flies down through Labrador to *Venezuela*, a distance of 2,500 miles ! The longest migration route of any bird is that of the Arctic tern that nests within the Arctic Circle and flies in winter as far as the *Antarctic Circle*, a little world tour of 11,000 miles or so !

These amazing movements of the birds remind us of our chapter on the adventures of the salmon and the eel ; and indeed the impulse that draws the salmon from the sea-jungle to the mountain rivers and lures the eel from the quiet country ponds to the sea-depths may be one of the most powerful factors in bird migration. The love of home, of the place where one was born, is one of the strangest instincts in the world of nature : a pair of birds coming up from Africa will return to the same little English village, even to the same tree, to the remains of the old nest, to bring into the world a new family. Perhaps our modern psychologists, who tell us that the influences we feel when very young will be our guiding stars throughout our lives, may find a fruitful field for study in this power of the love of home in birds.

Beside the mystery of *why* birds migrate is the mystery of *how* they do it. It is a wonder to some people that birds can find their way across trackless oceans and miles of jungle and desert. Endless have been the speculations of naturalists about this mystery. Some say birds "follow the sun." Some say they are "blown by the seasonal winds." Others credit the creatures with some intelligence, and say they are quite capable of noting landmarks—many birds, it is true, follow the rivers and coasts. Yet other speculators hold that the "homing instinct" is as mechanical as the pull of a magnet. It has been suggested, too, that birds are even more keen-sighted than they are known to be, and that they can see places in foreshortened vision, like the cameras with telephoto lenses. . . .

At any rate there does not seem to be about bird migration anything more mysterious than there is about the migration of the salmon and the eel. With some birds we

know that in autumn adults go ahead of the young in the first southward movements, so that it may be they act as guides for the latter on the journey already familiar to themselves. It does not seem at all probable that any young birds set out on a migration they have never undertaken before without being accompanied by some older birds who have followed the route at the last migration. Migration, then, would seem to be like the tradition of men, a habit handed down from generation to generation. We have many thousands of facts to prove that young birds are most imitative and learn the ways of life from their parents, who in many cases deliberately teach, and demonstrate for, their young.

Finally, we can see that creatures who fly twice a year between Africa and England must be a triumph of adaptation to an aerial environment. They must be better fitted for flight even than the insects, and since they are vertebrate creatures—creatures with a backbone and skeleton—their bones must be light and very skilfully arranged on their bodies.

A bird's skeleton is very airy. There are air spaces in many of the bones and air sacs lining the skin. The heaviest part of a bird is placed in the very middle of the body, this keeping the balance when the bird is on the wing.

In the following chapters we shall describe the appearance of most of the common birds of our land, so that we can identify them when we are next among birds. We shall give an account of the ways of life of a few of them and shall enter here and there into their adventures and struggles. But let us not forget the marvel of a bird's body, as we have glanced at it in these two chapters—at these conquerors of the air who have descended from crawling reptiles—and when we note that a bird is a "visitor" or "migrant" to our country, let us recall that he has winged his way in two or three weeks across oceans and deserts that once were many months' journeys for men.

# CHAPTER VI

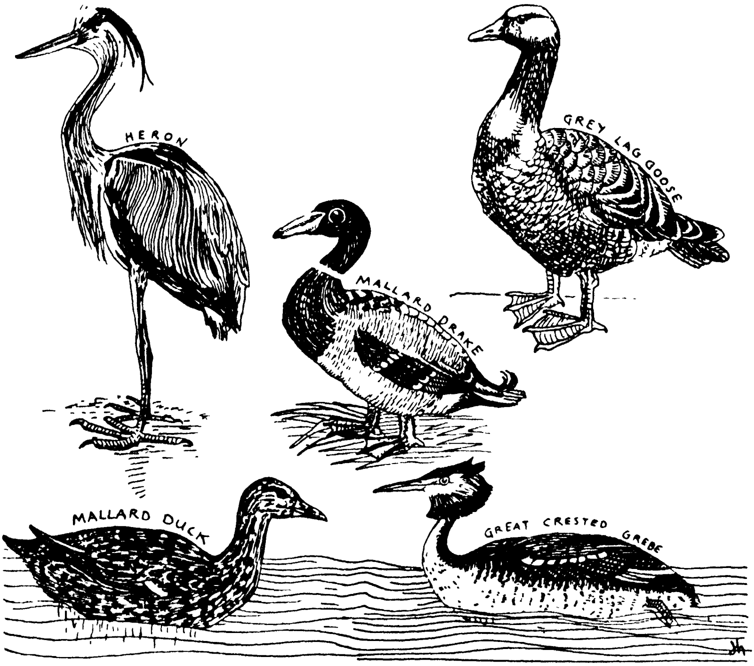
# WATER FOWL AND GAME BIRDS

IN THE DAYS when our heaviest armaments were bows and arrows, the yew-tree and the grey goose were of equal importance to English warriors : the yew-tree supplied the best wood for the weapon, and the grey goose supplied the best feathers with which the arrows were fletched. One of the old ballads of the bowmen of England, which describes the making of the bow and arrow, piece by piece, runs in one verse :

*What of the shaft ?*
*The shaft was cut in England ;*
*A long shaft, a strong shaft,*
*Barbed and trim and true ;*
*So we'll drink all together*
*To the grey goose feather*
*And the land where the grey goose flew.*

As many an ancient song tells us, the grey goose was in those days one of the most familiar symbols of England. The grey "lag-goose" it came to be called, because it lagged behind when other kinds of geese took wing to foreign parts. It was the only kind of wild goose that bred in the British Isles : a real British goose.

The grey lag-goose is still the only wild goose that breeds in Britain ; but its nests are now confined to the north of Scotland. Its descendants, however, are bred in their thousands in farms throughout the country, the domestic goose being descended from the wild "grey-lag." Under the hand of man the grey plumage has almost




entirely disappeared, most of the tame geese being practically pure white.

You can still come across wild grey-lags in parts of the country during the winter ; but they will be mostly migrants from abroad, who arrive in great numbers in September and October and leave in March and April. The grey-lag, however, is greatly outnumbered to-day by three other closely related geese, the Pink-Footed, the White-Footed and the Brent.

A flight of wild geese, which may often be seen at these seasons of the year on our eastern and southern coasts, is a most thrilling sight. Geese fly in formation—no one knows why. They may fly in a wedge-shaped group, in a wedge of two lines meeting at a point, the point being the foremost bird, who appears to be a sort of leader, or they may fly in a straight slanting line, one bird behind and to one side of another.

**Grey-Lag** (*Anser anser*). Although a large bird, the wild grey-lag is smaller than the tame goose of the farm. Its plumage is brown-grey with a large light blue-grey patch on the wing. Its feet are pinkish, its bill pink, sometimes fading into orange.

**Pink-Footed** (*Anser frachyrhynchus*). The pink-footed is nowadays by far the most plentiful of the wild grey geese in Britain. In the estuaries of the Humber, the Severn, the Dee, in East Anglia and elsewhere these geese are to be found in thousands every winter. They are the first to arrive in the autumn, some coming as early as August or September, but mainly in October or November. They are very like the grey-lag, but are smaller birds and have feet and legs of a brighter pink. They may be known at once from the grey-lag by the fact that they have a pink band in the middle of the beak, the rest of the beak being black.

**White-fronted** (*Anser albifrons*). About the same size as the pink-footed the white-fronted has a patch of white feathers round the pale orange beak.

Geese and swans are very closely related, and there are, in various countries, several species of bird half-way between geese and swans. According to the laws of England, swans are " birds royal." On the Thames, for instance, ancient custom allows the Dyers' Company and the Vintners' Company to keep swans. At certain seasons of the year the King's men and the men of these two companies can be seen chasing their respective swans this way and that across the river. This business, called " upping," is carried out in small rowing boats, the captured birds being marked upon the beak as the property of the Crown and of these two companies.

The most obvious feature of the swan is the long arched neck which has developed to save the bird the trouble of diving to obtain food from the bed of ponds and streams. One can often find the nests of these half-tame swans of

our rivers and parks ; built of reeds and long grasses on the edge of the water, the mother-swan whiles away the time of incubation by poking at and tidying and adding to the nest until it is a goodly structure. The cygnets, as young swans are called, have rough grey feathers and are nearly a year old before the smooth white plumage of full swanhood covers them.

Most species of swan are white, but there is a species of black swan which has a red beak, native to Australia, kept frequently on ornamental waters.

The common swan of English parks and rivers (*Cygnus olor*) is called the mute swan ; though why it should be so called is a mystery, since it is not dumb, though its voice is a most unpleasing croak and it usually chooses to hiss. It is pure white with an orange beak that has a black knob above it, and black legs and feet. It is not found wild in Britain.

Wild ducks can be separated into two main groups, those that dive for their food and the non-divers. The diving ducks have shorter wings and flatter bodies : they swim low in the water, often with their backs and tails awash. The non-divers usually feed at night, and when one sees them by day they are generally sleeping, preening or washing. Their day begins in the evening with the " flight " to the feeding grounds. The diving ducks with few exceptions have no regular flighting habits and feed entirely by day.

In the wild state, ducks are to be found in great numbers throughout our land wherever there are stretches of water, in such places as the Broads ; but we need not despise the parks of London and other cities, which can show us at close quarters nearly every type of duck which is to be found wild in our land, and several interesting foreign types as well. In the London parks, for instance, we can see our native mallard, wigeon, teal, pintail, shoveller, garganey, gadwall, etc. Most of these are pinioned—that is, their wings are clipped to prevent their flying off—but mallard are in a state of nature in the parks, and seem perfectly content to remain.

**Mallard** (*Anas boschas*). Found nesting in every county of England the mallard is the easiest duck to study. A beautiful bird, the head and neck of the drake (male) are a beautiful green colour, and this is separated from the rich chestnut plumage of the breast by a white collar. The four middle tail feathers curl upwards. For a short time during the summer the drake " goes into eclipse," as do so many birds of the duck tribe, losing his colour and becoming a mottled brown like the duck. He may be known from the female at this season by his rasping note : her note is a clear sharp " quack." In swans and geese the male and female birds are the same, but in ducks there is almost always a difference of colour.

**Teal** (*Querquedula crecca*). Next to the mallard the teal is the most common duck in Britain. It is the smallest of the ducks, being about the size of a pigeon. The drake has a green streak on each side of his head, rest of head and neck being brown ; body mottled, front yellow and white, with yellow on tail. The duck is mottled brown with a green patch on her wings.

**Garganey** or **Summer Teal** (*Querquedula querquedula*). Rather larger than the common teal the garganey or summer teal is the only summer visitor to these islands, all other visitors coming in the autumn and leaving in the spring. The general colours of both duck and drake are grey and brown, the drake having a white stripe over the eye and "half moon" pattern feathers on the breast. They nest in the Norfolk Broads, but not many of them, the garganey being the rarest of our wild ducks.

**Shoveller** (*Spatula clypeata*). In ways of life very like teal, the shovellers, when feeding, have a habit of swimming along with beaks half under water, sifting mud and water for worms and insects. A large bird, with a large, ungainly, spoon-shaped beak, the plumage is grey and blue ; the drake having a white breast and rich orange belly and a

dark green head and neck. The duck is mottled brown with blue and grey on her wings.

**Pintail** (*Dafila acuta*). So-called from the long pointed tail feathers, a large bird, the drake with a brown-green head, a white front, a closely mottled blue-grey back and gay wing-feathers with touches of yellow and purple. The duck a yellow-brown mottled bird with a patch of green in her wings.

**Wigeon** (*Mareca penelope*). After mallard and teal, these are the most common wild duck of our island. With ruddy brown head and neck, white belly, grey back and green and grey wings (with a few white feathers) the drake is a handsome bird, the duck being a sober mottled brown-grey with a tinge of green and white on wing. They should perhaps be numbered among our sea-birds, since their favourite food is the sea grass, and they are more often found on the coast and estuaries than anywhere else.

**Pochard** (*Nyroca ferina*). The head of the drake pochard is a smooth chestnut brown, across the breast and back runs a broad black band, the rest of the body being white, with a faint grey or bluish mottle, the wing tips and tail feathers a dark grey. The duck is a warm yellow-brown finely mottled in darker brown, with various greys in her wings. A diver.

**Tufted Pochard** (*Nyroca fuligula*). Head and chest dark green-black, with a down-hanging tuft of black feathers behind the head, back green-black, front white, with band of white on wings, which are ribbed in green-grey. The duck has brown head, neck and back (and brown head-tuft), yellowish-brown front and dark brown tail. This bird nests among rushes, coarse grass, or under bushes beside lakes and ponds in colonies, especially in Sussex, Staffordshire, Shropshire and parts of Scotland. In the London parks it is most amusing to watch the very young birds—a day or two old only perhaps, little bunches of dark brown

feathers—diving under the water with all the expertness of their mother.

**Eider** (*Somateria mollissima*). Although most of us have used eiderdown, probably few of us have seen the eider duck, which nests in parts of Northumberland and in Scotland and visits us in small flocks from the continent. One of the rarer British ducks, the eider is well worth seeing —a two-foot duck with a white neck, a black cap on head and a green patch on the back of the neck, with a greenish beak and legs, a white and yellow back, a pinkish or even crimson hue on the chest and deep black underparts, with white and brown wings. The duck is a drab brown-mottled bird with two flecks of white on each wing and a black beak. It is more properly a sea duck than an inland bird.

**Scheld Duck** or **Scheldrake** (*Tadorna tadorna*). This brilliant bird—the duck is as gay as her husband—has a bright glossy green head and neck, a coral-red beak with a knob atop it (like the black knob of the swan)—the female scheld lacks this knob—a white neck with a broad dull-orange band beneath it, the rest of the body grey-white save for a grey mottled band running down the front from neck to tail. Wing-feathers grey, orange-red and green.

**Gadwall** (*Anas strepera*). Head and neck yellow-brown mottled, wings brown and grey with patch of white, front mottled blue and white, back mottled grey, green, blue and white. The duck lacks any blue or green, but is otherwise not unlike the drake.

Some few other ducks, such as the **Goldeneye** (*Glaucionetta clangula*) and the **Scoter** (*Melanitta nigra*), are found in the wilder parts of Britain, more especially in the north, but we had better pass on to the great group of inland game birds and waterfowl.

As everyone knows, multitudes of these " game birds " are reared by hand and freed for shooting at the right season of the year ; but all these birds also breed wild.

" When we speak of game birds we at once think of pheasants, partridges, grouse, ptarmigan and other birds that serve as a target for the sportsman and food for our table ; these are but a few of the many different kinds included under that title.

" The most familiar group of the game birds are the pheasants, of which there are a large number of different kinds. They are of Eastern origin, and have been introduced into many parts of the world. It has been said that the common pheasant was brought to the British Isles by the Romans, but this statement is open to doubt. . . . Most of the pheasants that frequent the coverts[1] of the British Isles are mongrels that have arisen from interbreeding with the Chinese ring-necked pheasant, a bird first brought over from China about two hundred years ago. More recently, however, the Japanese pheasant, the Mongolian pheasant, and the Prince of Wales's Pheasant (from Afghanistan) were introduced into the coverts of Britain, with the result that many birds are now to be found which show traces of several breeds."[2] The first pheasant to be brought to this country, the original common pheasant (*Phasianus colchicus*) " has, in the case of the cock bird, a dark green neck. The Mongolian cock (*Phasianus mongolicus*) has a broad white neck-band and white wing-coverts.[3] The Chinese bird (*Phasianus torquatus*) also has a white wing. The Japanese (*Phasianus versicolor*) has a handsome plumage, exhibiting shades of purple, blue and green."[4]

Because so many kinds of pheasant now make nests together and bring up families, their children are naturally very varied, and so we can describe in a most general way the sort of bird you can expect a pheasant to be.

[1] The word " covert " means " hiding place," and is used to describe the little coppices, bush-clumps or undergrowths in which game birds nest and hide.

[2] W. S. Berridge, F.Z.S., *All about Birds*, p. 227.

[3] The wing coverts are small feathers growing round the big stiff wing feathers, like bushes round the boles of tall trees.

[4] Richard Clapham, *The A.B.C. of Shooting*, pp. 60–1.

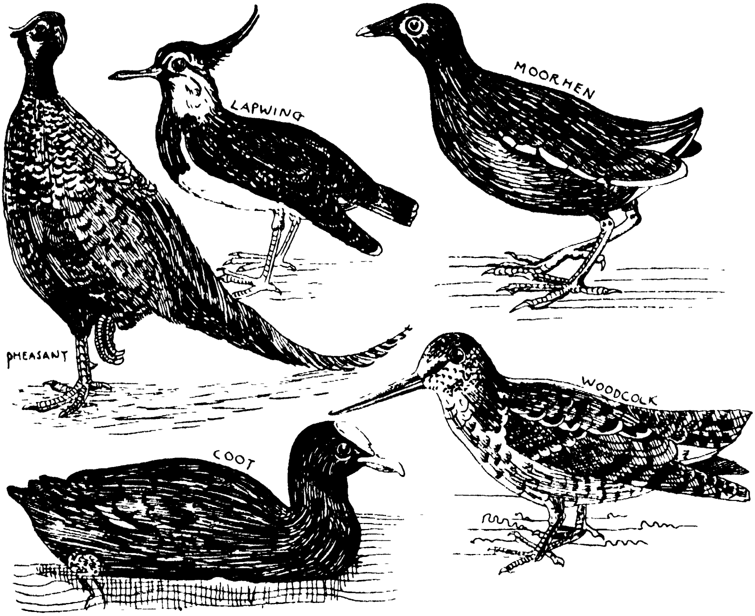
A biggish bird, length from beak-tip to tail usually about three feet—but then, the pheasant has a magnificent tail, about half the total length of the bird—with a scarlet headdress and cheeks, a golden beak, and a glittering dark green neck, with a dark green top-knot or spur on the back of the head ; chest and front are a mottled bronze and brown, lightening to gold on the underparts, with brown-grey feathers about the legs. The back is set with half-eye patterns, like the peacock's, in grey and white on a background of deep bronze feathers ; in the wings and tail are feathers of a lighter green than those upon the neck : the long, pointed tail being brown and green, barred with grey and black. The hen is a rather smaller and browner bird, with no spur on the head.

The pheasant is " a woodland species, thriving best in protected coverts ; it roosts in trees for protection, but is, in other ways, a ground bird, nesting on the level and running swiftly to escape an enemy, unless forced to take flight, when it rises with a whirr of round wings, often ' rocketing ' over the tree-tops ; it is then swift,"[1] but cannot keep up a long flight.

**Partridge** (*Perdrix cinerea*). The forehead, throat and sides of the head of the common partridge are a chestnut colour. The back is brown and grey with dark bars and buff streaks, the tail chestnut-red. The breast is grey, finely barred with black, the under-parts are white with a chestnut-brown horseshoe. The cock differs from the hen in the brighter yellowish chestnut of the head and greyer neck, and in slightly different markings on the wings.

**Red-Legged Partridge** (*Caccatis rufa*). A French species brought into England in 1673 and now quite common. The red-legged partridge has a brighter colour than our own bird, has a red beak and red legs, the throat is white-edged with a band of black, with a blue-grey patch on the sides.

[1] T. A. Coward, *The Birds of the British Isles and their Eggs*, p. 346.




**Grouse** (*Lagopus scoticus*). Of several species of grouse in Britain, the common or red grouse is the only kind not found anywhere save in our island. With a red cap on the head, a mottled brownish head, neck and chest, deepening into a bronze and black mottle over the body, with dark grey wing and tail tips and white legs, the grouse is perhaps the favourite game bird of sportsmen. The hen is a smaller and lighter-coloured bird; the cock is not a big bird, slightly larger than partridge, about one foot and a third in length. There are considerable variations in the plumage colours, and of the other species the **Black Grouse** (*Tetrao tetrix*) and the **Sand Grouse** (*Syrrhaptes paradoxus*) are the most common. We must not forget the **Ptarmigan** (*Lagopus mutus*), a near relative of the common red grouse, which it closely resembles, though is a greyer and whiter bird, with no chestnut colour and a smaller red cap on the head. Last but not least in the grouse family is the **Capercaillie** (*Tetrao urogallus*). The cock capercaillie is a large bird,

some three feet (or a little less) in length, a beautiful but rather sombre creature dressed in shining black and grey with touches of glinting green, with strong, curved, white bill and a splash of red above each eye. He has a fine grey-brown tail which he can spread peacock fashion, when it is seen to have a bar of black and white semi-circles. The hen is a smaller bird, about two feet in length, with a rounded red tail.

Quail (*Coturnix coturnix*). The smallest of our game birds, about seven inches in length, the quail is not unlike a small partridge, and is of a sandy brown on the head and back. The chin and throat are white with several black bars, like chains of office hanging around the neck. The breast is buff and may have tints of orange. The hen lacks the black neck markings.

All the game birds we have mentioned after the pheasant, belong to the pheasant order, *Galliformes* ; and we now come to birds in the order *Charadriiformes*, the order of the pigeons and gulls, and of several birds we have already dealt with in Book One, Chapter V, such as the razor-bill, guillemot, puffin, tern, curlew, oyster-catcher and turnstone.

Woodcock (*Scolopax rusticola*). A keen wildfowler has written : " A woodcock is such a wonderful picture, so perfect a blending of all the delicate tints of the autumn woods, that one has a feeling of desecration in taking the life of such an exquisite creature. I cannot help wishing that it was possible to bring the bird to life again."[1] Though woodcock are not very common as a *resident* species, their nests are increasing in numbers, especially in the south-eastern counties—in Kent, Sussex and Hampshire. Vast numbers of woodcock, however, arrive about October from the wild, uninhabited parts of northern Europe, and depart about March. They spend their days generally hidden in woods, flying out in the evening over marshes and river

[1] Major Kenneth Dawson, *Marsh and Mudflat*, p. 69.

banks, seeking the worms, insects and water-snails that are their principal food. These migrants are found especially in the western counties. A smallish bird, a little over a foot in length, the woodcock has a long, pointed, yellowish beak : head, back and wings mottled and barred in many tints and colours, more particularly brown and bronzy gold : the front of the bird mottled white and grey. Legs and feet yellow-brown. One interesting thing about woodcock is the way the parent birds sometimes carry the young to the feeding grounds and home again after a meal, perhaps to save the time and trouble of taking food to the nest. They hug the young birds between the thighs and the body.

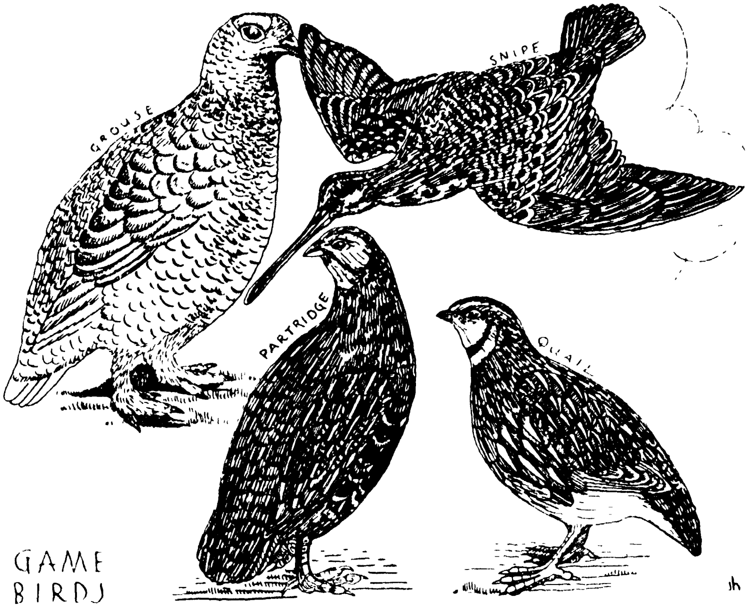
**Snipe** (*Gallinago coelestis*). The snipe is a migrant from the south, arriving in large numbers in the spring, and nesting in swamps, marshes and damp meadows in April. The eggs, usually four in number, are greenish olive, spotted and blotched in various shades of brown, with a few black markings near the larger end. The young when first hatched are reddish chestnut, mottled with black and white. In form, the grown bird is not unlike the woodcock, with a long pointed beak and a mottled body—brown back, yellow and white front. It is a smaller bird than the woodcock, being less than a foot in length. The eyes of the snipe are set far back in the head, so that the bird can see behind even when digging with the beak. They are very "ca-canny," and fly in zig-zags, probably for protection against sportsmen. Other species are the **Great Snipe** (*Gallinago major*) and the **Jack Snipe** (*Gallinago gallinula*). The snipes are all very similar. The smallest is the Jack, about seven inches.

**Plover** (*Vanellus vanellus*). Sometimes called **Green Plover.** Also well known as **Lapwing** and **Peewit,** the first name describing the slow stately flapping of the wings in flight, the second mimicking the bird's habitual cry. These birds are found all over Britain in great numbers, particularly among marshlands, on moors and downs, over

ploughed fields, beside streams and on the seashore. They are shot more often in the eastern counties. You can know the peewit at once by the glossy green-black crest that rises from the back of his head and curls forward, and by the green crown, the white collar, the green glossy back, the white tail banded with black at the tip (though the outer feathers on each side of the tail are white to the tip), by the black front, white underparts and the orange legs and feet. The beak is black. The hen bird has a shorter crest and a more pointed wing. There are other plovers, notably **Grey Plover** (*Squatarola squatarola*), **Golden Plover** (*Charadrius apricarius*), **Ringed Plover** (*Aegialitis hiaticula*), and **Kentish Plover** (*Charadrius alexandrinus*). None of these birds has crests. The grey and golden plovers are black-fronted birds with a streak of white down each side, and mottled backs—grey and gold respectively. The ringed and the Kentish plovers are very small birds, about half the size of the others. The green, grey, and golden plovers are round about the size of pigeons: the ringed and Kentish plovers are about seven inches in length—the Kentish a bit smaller. The Kentish has a chestnut cap, a grey-brown back, black legs, feet and beak, white front with black markings on the shoulders and cheeks. The ringed plover is very similar, but the shoulder marks join in a deep ring round the neck and the cap is grey and black and the legs yellow, the beak being yellow with a black tip.

**Dotterel** (*Eurdromias morinellus*). Found on hills and moors of the north during the summer, the dotterel flights over the southern counties of England in May and September. Cock and hen alike. A white stripe over each eye. Chin white ; breast ash-brown, crossed by a narrow white band ; middle front chestnut, lower parts black.

**Sandpiper** (*Tringa hypoleuca*). The group of birds known as sandpipers got their name from the shrill piping note, plaintive " wheet, wheet, wheet," which they cry on the wing. These birds are common beside lakes and on the




gravel shores of streams and rivers. They run along on the edge of the water with an up-and-down dancing movement, searching for worms, flies and insects. Most wading birds make the rudest nests, if they make any nests at all ; but the sandpiper builds up quite a decent structure of grass and leaves in which to lay her pale clay-buff eggs, spotted with brown (usually four eggs). An eight-inch-long bird, of misty colouring, grey back, head and wings crossed by shadows of black, front white. Other sandpipers include **Green Sandpiper** (*Tringa ochropus*), **Purple Sandpiper** (*Erolia marituna*), **Curlew Sandpiper** (*Erolia testacea*), and **Dunlin** (*Erolia alpina schinzii*).

**Redshank** (*Totanus calidris*). A twelve-inch bird with a sharp, straight, dark-coloured beak, with a body mottled in brown and yellow (fairly bold brown spots), with white underparts and white tail feathers, and brilliant orange legs and feet.

**Greenshank** (*Totanus camescens*). A slightly larger bird than the redshank, very similar in shape and colour: the beak longer and curling upwards, the wings darker, greyish. Legs and feet green.

**Godwit** (*Limosa lapponica lapponica*). Long-legged, long-tailed birds about the size of pigeons, of a red-brown colour in summer (back mottled, wings greyish) and white-greyish in winter.

We now come to one or two important birds in the order *Gruiformes*.

**Waterhen** (*Gallinula chloropus chloropus*). Sometimes called **Moorhen.** About a foot in length, the waterhen is a dark bird, with a back of dark olive-brown, head, neck and underparts bluish grey, with a line of white flecks in the wings and tail, green legs and feet with a yellowish band at the top of the legs, beak orange with yellow tip. They make their nests amid reeds and rushes, sometimes under bushes or even trees. Usually the waterhen raises two or three families each season. The chicks of the first family help to feed and care for the next family and to help the mother when brooding. A waterhen is easily known; for, when swimming, it bobs its head up and down all the time, and when walking it raises its tail at each step, revealing white tail coverts.

**Water Rail** (*Rallus aquaticus*). The water-rail is a long-legged, short-tailed bird about one foot in length, dressed in graceful tones, a dull silver-blue chest and neck, mottled grey and white underparts with yellow feathers around the legs, which are green-grey : the back is brown mottled, and the long dull-chestnut beak curls downwards slightly. There are plenty of British water-rails all the year round beside reedy streams, pools, ponds and marshes ; but large numbers arrive from the continent in the autumn, to stay the winter. The British residents make nests in early April of reeds and sedge leaves, laying 7 to 11 cream-white eggs,

with brown and grey spots. They raise two families each season.

**Corn Crake** (*Crex crex*). Sometimes called **Landrail.** A pretty little bird, just less than a foot in length, with blue cheeks, a buff chest, white underparts, and yellow-brown mottled head, back, wings and tail. A summer migrant, arriving in this country in April and leaving again in October (though a few remain all the year round in the west country and Ireland), the landrail is to be looked for where there are large open grass and clover fields, where it lives on insects and slugs. The nest is on the ground amid the grass or clover, carefully built of coarse dead grasses, neatly interwoven and lined with fine grass. Nine to twelve eggs grey-white with sometimes tinge of yellow blotched with rust-brown or purplish grey.

**Coot** (*Fulica atra*). A large black bird with a yellow beak and forehead and green legs and feet, the black being relieved by fine lines of white on the sides. The coot is found on most of the open sheets of water throughout the country, the bird diving for its food—insects and water-plants. The nest is a huge structure of reeds and rushes placed well away from the shore in a clump of reeds, and the eggs, which number 7 to 10, are very pale stone colour, minutely speckled and dotted with dark brown—7 to 9 in number. Nesting from March until May.

We now come to the family *Ciconiiformes*, sub-order *Ardeae*, the order of the herons and bitterns. (There are very few bitterns left in Britain now, though at one time they were very common indeed.)

**Heron** (*Ardea cinerea*). This great, graceful gird, with a body-length of three feet, legs of seven inches, and wings 19 inches in length, is found in fair numbers on most of our larger rivers, and on lakes and fens. They may often be seen standing ankle-deep in the water, and watching with untiring patience for the prey which never seems to satisfy

their appetite—fish, frogs, worms, mice, molluscs, insects, smaller waterfowl : at all of these the great birds strike with their dagger-shaped beak, a beak twice as long as their head, and of a golden yellow colour. The head, neck and front of the heron are white, but from the neck down to the belly run long grey marks, like rows of oblong dark buttons, and from each eye a black streak runs to the back of the head, and a trailing plume of black feathers hangs down the back of the neck. The back of the heron is a slate-grey colour, with black wing-tips ; legs and feet dark. These birds do not often swim or walk, but are swift and skilled flyers, in spite of their great size, which may be accounted for by the fact that they are very light in weight. Though in some birds the span of the spread wings may be nearly six feet, the weight of the whole bird will be less than four pounds. They are very beautiful in flight—the slow beat of the large wings, the upheld head and curled-back neck, the straight-held-out legs, as they wheel over the trees of the heronry, make an unforgettable sight. The heronry is the nesting place of perhaps from 6 to 60 herons. They nest in old tall trees, their nests being of sticks lined with grass and roots. From three to five bluish-green eggs are laid in March, and both parents share the duty of providing the newly hatched chicks with food. As soon as the young birds are hatched a heronry is a busy and noisy scene. " All day long the old birds are flying backwards and forwards, planing down on to the nests, their necks bulging with fish for the youngsters, and launching off again for fresh supplies."

Now, last in our brief survey of the waterfowl and game birds of our land, we come to the family called *Colymbiformes*, the order of the divers and grebes.[1]

Great Crested Grebe (*Podiceps cristatus*). Also known as the **Loon.** A bird of nearly two feet in length, with a sharp-pointed beak, a white face and red eye, with a tufted brown head with a little upturned topknot on the back, and a thick ring of hanging feathers, like a sort of ruff

[1] For an account of the great northern diver, see Book One, Chapter V.

around its neck, these feathers being pinky brown. The neck, chest and underparts white, the back (including back of the long neck) a browny grey, with brown-grey wings set with a patch of white. Green legs set far back on body, so that the bird is an awkward waddler on land, but a swift diver, gliding under water with outstretched wings : its feet are not webbed, but each toe is flattened like an oar-blade. The bird is a strong flyer. The nests are made in April and May—large floating masses of decaying vegetation well hidden among thick reeds. Four eggs, yellowish white when laid, soon discoloured by decaying vegetables in nest. The young when first hatched are dark brown striped with white. They are cared for by both parents, who often carry them on their backs.

**Dabchick** or **Little Grebe** (*Podiceps ruficolis*). In habits and ways of life and form like the great crested grebe, the dabchick differs mainly in its smaller size and its plumage. Less than a foot in length, with a blue-black body, cheeks pinkish, a touch of brown on the underparts, the dabchick lacks the thick collar of its larger relative.

# CHAPTER VII

# CUCKOOS, WOODPECKERS, SWIFTS, KINGFISHERS, OWLS AND OTHERS

THE CUCKOO, as most people know, lays her eggs in the nests of other birds—mostly in the nests of small birds which eat insects, for the cuckoo is insectivorous, with a special liking for hairy caterpillars.

Sometimes the other birds object to having a strange egg thrust upon them, and resist the approach of the cuckoo with loud screams and a furious beating of wings. In order to get their way, several cuckoos may combine to drive away hostile birds so that the hen cuckoo may lay her egg safely in another bird's nest. She never lays more than one egg in one nest.

As a rule, however, the cuckoo is stealthy. She finds a nest upon which a small bird is sitting, and takes up a position of vantage from which she watches the chosen nest intently. On one of those rare occasions when a mother-bird leaves her eggs, the cuckoo will glide down silently, and lifting one of the mother-bird's eggs in her beak, she will lay her own egg in its place, and as silently glide away. She will make a meal of the egg she has stolen.

Sometimes the hen cuckoo will lay her egg on the ground, and wait for a chance to carry it in her beak to a neighbouring nest, when she will carry another egg away in the same fashion. In whatever manner the substitution takes place, multitudes of small birds every season find a strange egg " planted " on them in this way. It is not known

whether the foster-mother bird knows it is not her egg, or whether she is deceived by the substitution and believes the egg to be her own. However it be, she faithfully hatches the cuckoo's egg alongside her own.

Now, the cuckoo has been more than cunning. In selecting the nest of a bird smaller than herself she has ensured that her own baby shall " rule the roost " in a very literal sense. For of course young cuckoo when he hatches is bigger than his false brothers and sisters, the true children of his foster-mother ; and he proceeds to elbow them out of the nest. When " mother " and " father " are out of the way fetching tasty caterpillars, young cuckoo tips the other babies out of the nest. One by one, over the top they go, to perish miserably of cold and hunger, or be eaten by the woodland mammals or bird-eating birds.

Which suggests a better hobby than egg-collecting for all bird-lovers who hear the note of the cuckoo in the spring. Go out to find nests in which are cuckoos' eggs and, if you would keep birds as pets, rescue the victims of young cuckoos. Cuckoos' eggs have been found in the nests of more than one hundred other species of bird. The chief victims are redstarts, hedge sparrows, reed warblers and meadow pipits.

It is probable that a cuckoo seeks to lay her eggs in the nest of that species of bird by which she herself was brought up ; and sometimes the foster-parents seem only too glad to receive the young cuckoo. They appear to remember having brought up one of these big troublesome birds before, and have grown to love the changeling.

Now and then, of course, there is a more severe struggle in the nest than usual. It is not unknown for a cuckoo to lay her egg in a nest which has already received the attention of another hen cuckoo ; and two young cuckoos may hatch side by side in the nest of a poor little reed warbler. When these young cuckoos try to tip each other out of the nest, it is a battle royal indeed ; but one must win.

Cuckoos are not always successful in laying their eggs in other birds' nests. One of the cuckoo's victims is the little

jenny wren whose nest is as great a masterpiece as that of the magpie. I have known wrens to make half a dozen nests before they are satisfied with the architecture. They line the nests with wools and feathers, and the entrance is a small round hole at the side.[1] The golden crested wren makes the most beautiful nest of any bird I know of. It is cylindrical in shape and covered *outside* with lovely silver lichen, which acts like slates or tiles.

Sometimes cuckoos half wreck these lovely nests, as they try to squeeze through the tiny entrance hole in order to lay their egg ; and many smashed cuckoos' eggs have been found beneath wrens' nests. When the cuckoo does succeed in " planting " her egg on unsuspecting jenny wren, young cuckoo when hatched will have a stiff task to eject all his brothers and sisters through that entrance hole. For though the wren is little her family is great. I have found seventeen in a nest.

The little rusty-brown adult wren is but three inches in length, the blue-grey cuckoo is 12 inches, fully grown. Yet when the foundling cuckoo is nearly full grown and can fly, the tiny foster-mother will sometimes continue to feed him, perching on his broad back and popping a hairy caterpillar into his large, gaping, greedy beak.

The cuckoos are grouped with the parrots into the order *Cuculiformes* ; but the cuckoos are the only species found wild in our land.

Cuckoo (*Cuculus canorus*). As in most insect-eating birds, the top beak (upper mandible, to use the scientific phrase) is longer than the lower one, and crooks over downward. The head, neck and back of the cuckoo are blue-grey. The wings and tail are grey and black, the front is white mottled with blue-grey, the under-tail parts pinky-mottled. The bird is a migrant, coming up from the south about the

[1] Perhaps the best description of the nest of the jenny wren is this : " The nest has the form of an upright egg, while in the middle of one side is a little postern, as it were, by which the bird goes in and out."

middle of April and leaving in July (the young follow their parents abroad in September). The eggs are apt to vary greatly in colouring.

We now turn to the fascinating order *Coraciiformes*.

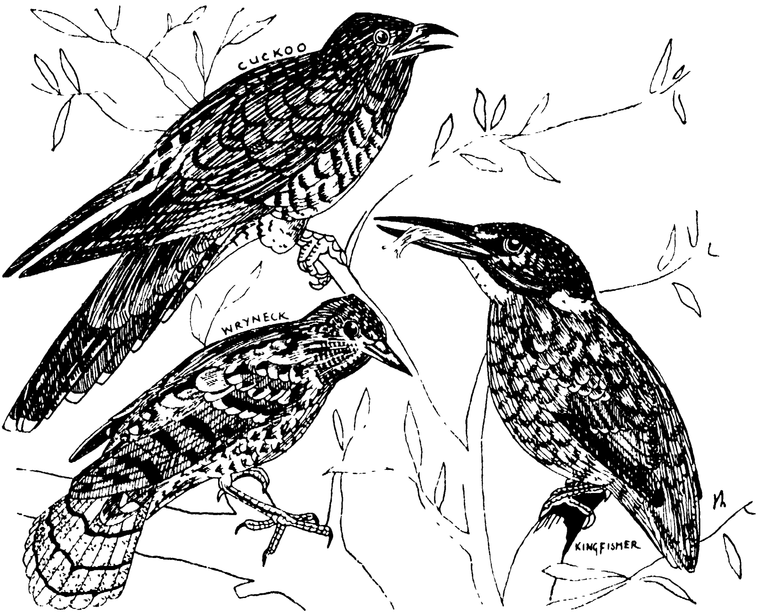
**Woodpecker** (*Picus viridis*). In the spring the woods echo to the laughter of the green woodpecker, a large and brilliantly coloured bird, green and yellow, with a red crown. As you may gather from his name he clings to trees and pecks at the wood of branch and bole, picking off the trees his favourite insects, ants and caterpillars, upon which he principally subsists. He also pecks his nest in the tree.

Whereas robins and starlings and many other birds make their nests in such holes as they can find, the industrious woodpecker pecks his own hole in the tree. Every spring the woodpecker drives a new clean hole into a tree trunk for his nest. The bird will only work in soft, rotten wood, though he does not mind pecking through sound hard wood so long as he can find soft wood in the heart of the tree. Often enough a starling comes along and drives the woodpecker out. Nearly all the first attempts at hole-making by the green woodpeckers are taken possession of by starlings.

The woodpecker tries again, and pecks a large cave in the tree below the entrance hole he has made. The nest is often two feet deep below the entrance hole ; and it is not a " nest " in the sense that the nursery of the wren is a nest. The eggs of the woodpecker are laid on the bare wood at the bottom of the nesting chamber.

If you are passing through a wood and come across a pile of little chips at the base of a tree, you can be pretty sure there is a woodpecker's nest somewhere within the trunk. It is probably pretty high up, though now and then one can come across an entrance hole sufficiently low for one to reach without climbing. Wait long enough and you will see the woodpecker himself.

A woodpecker cannot climb down head first, as some woodland birds can—the nuthatch, for instance. He goes




down the tree trunk in little jumps. He has to climb upwards in jerky movements, and uses his stiff tail feathers to prop himself with when climbing.

The green woodpecker has a tremendously long tongue with a prickly tip which he keeps in a sheath down his throat when not wanted. He uses this tongue to pick ants, caterpillars, and many other insects off the trees.

The greater spotted woodpecker (*Dryobates major*) stays in the cover of the woodland to a much greater extent than does his green cousin. He is a smaller bird, with black and white plumage. The lesser spotted woodpecker (*Dryobates minor*) is a smaller edition of the greater. He has no great strength, and can carve his nesting hole only out of the softest trees, such as apple, birch, ash, willow and cherry. The holes of the lesser spotted woodpeckers are too small for the starlings to use, though tree sparrows sometimes manage to steal the lesser spotted woodpecker's hole. The cock of this species has a red head.

**Swift** (*Apus apus*). The swift is especially built for one purpose—to spend his life on the wing and in the air. He never comes to earth for any purpose except to sleep. Like swallows and martins, the swifts sip up the water they require, as they skim over the surface of pond or stream. On a June day it would be hard to find a single spot in Britain where swifts are not in sight. At mid-summer, swifts are flying very early, at peep of dawn, and continue flying well into the dusk.

The wings of the swift are shaped like scythe-blades, and are tremendous in proportion to so small a bird. The swift's plumage is dull black—but one part of him flashes and gleams : his great black eyes. What amazing eyesight the bird must have to be able to pick up insects in the air when flying at fifty miles an hour !

The small feet and claws of the swift appear to grow direct out of the body without legs. The legs are actually very short and are almost hidden in the feathers. This is all an adaptation to life in the air. Rather on the principle of the sea-birds whose legs are set well back in order not to interfere with the " stream line " when swimming under water, the swift's legs are tiny so as not to interfere with the flow of air in flight. And like the sea-birds, the swift is awkward on land. He cannot walk or hop, and only uses his clawed feet to cling to a wall or a cliff-side.

Swifts nest in holes in cliffs and ruins, in church towers and thatched roofs, and under the eaves of houses. The swift glues the nest-material together with the aid of her saliva, making a little hard cup in which her two or three eggs are laid—pure white eggs, they are, very long and thin. When entering or leaving the nesting-holes the swifts can only shuffle along with difficulty. But how graceful they are when they spread those black wings and drop from the edge of the hole, sailing through the air !

Swifts make the shortest stay of any British migrant, coming at the end of April or early May, and leaving in July or early August, so soon as the young are reared. During the time of incubation, while the hen is hatching

the eggs, the cock flies screaming past the nesting-hole at intervals, and his wife often faintly answers him from the darkness inside. He visits her at times, probably feeds her, and spends part of his time sitting crouched beside her as she broods the eggs.

The swifts are not in any way related to the swallows and martins, whose way of life is so similar. The swallows and martins belong to the order *Passeriformes*, which we examine in the next chapter.

**Kingfisher** (*Alcedo atthis ispida*). How often have I seen the splendid kingfisher flashing along the reedy banks of the river Arun in Sussex ! He is, I suppose, the nearest approach we have, in our grey northern isle, to the parrakeets of tropical South America. Swift of flight, you rarely see him save out of the corner of your eye—and then he will seem like a flying red flame or a streak of blue light. A seven-inch bird with a long, powerful beak (upper beak longer than lower beak) and a head remarkably big for the body, cock and hen kingfishers are alike, save for the fact that her bottom beak is red : her top beak, like his entire beak, is slate-grey, with perhaps a touch of green. The head and back of these birds is a glittering, iridescent blue, in which green seems to flash in certain lights. The wings are blue, flecked and finely striped with red and grey. There is a red tuft in front of and behind each eye, and a blue band from the eye to the back. Behind this band a patch of white where the blue head joins the blue back. The throat is white, save for a fringe of red at the base of the beak. Chest and underparts bright red, blended with a warm chestnut on the belly. Legs and feet red. The kingfisher is a true British resident, living on our waterways all the year round. He is found beside lake, pond, canal or winding river, no less than by the rushing trout stream. He feeds mainly upon fish—for which our fishermen have waged relentless war upon him, although he is by no means a useless bird, as he eats countless numbers of freshwater shrimps that eat the eggs of sporting fish. The kingfisher perches upon a bough

overhanging the water, and there sits upright, tail pointed downward, head turned thoughtfully as he watches the water beneath. At times he hovers over the water, holding his position by rapidly whirring wings. Then splash ! he has dropped into the water like a bolt from the blue, and up he sweeps with a wriggling fish in his beak. He returns to his perch, and if his capture be a large fish he kills it by knocking it against the bough on which he perches. He then swallows the fish head first and continues his motionless watch. Kingfishers make their nests towards the end of April ; not really a nest at all, but a burrow, not unlike that of the puffin. It is a long, low tunnel in the bank beside the water, cut by both birds to a depth of three feet or so : the " nest " at the end of this burrow is a litter of fish bones and pebbles and pellets on which six, seven or eight round white eggs are laid. When they are nearly ready to leave the nest the young come to the opening of the burrow to receive food from their parents. The kingfishers often raise two families in a season.

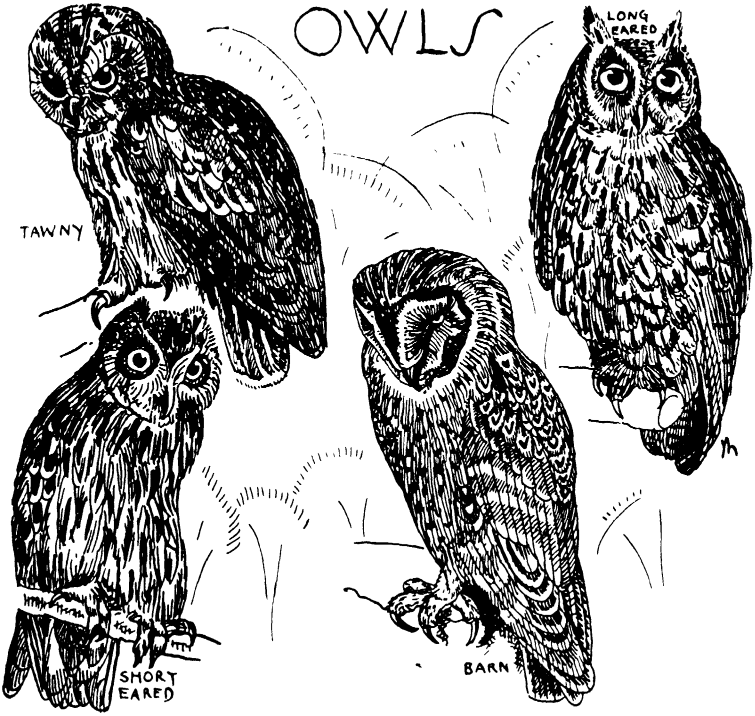
**Wryneck** (*Jynx torquilla*). A seven-inch migrant coming to us about the same time as the cockoo, and therefore called in some places the " cuckoo's mate." Like the cuckoo, too, it feeds on insects, chiefly ants, which it searches for on the ground or on tree trunks ; having a long, sticky tongue, this bird licks up the insects with a speed that has to be seen to be believed. A dull-looking bird, back and head mottled blue-grey, the square tail blue-grey barred with black, the front a bluey fawn. Nests in holes in trees which it finds. Cock helps hen to incubate eggs and feed young.

**Nightjar** (*Caprimalgus europaeus*). The latest of all our migrants, the nightjars do not as a rule arrive before the middle of May, and leave early in September. In that time they raise a family of two. They make no nest, but lay their two white eggs, blotched and mottled with brown and lilac, on the bare ground without any attempt to hide it. But the parents, who share the task of incubating and feeding the

young, are coloured so as to resemble the bare ground, and sit so tightly on the eggs that you might walk upon the bird before noticing. The plumage of both birds is alike—ash-grey streaked and spotted with brown : the cock has a thin white line in the wing and tail. This bird is also known as the **Goatsucker.**

**Owls.** No one is ever likely to mistake an owl for any other kind of bird. The large eyes, each set in a saucer-like ring of feathers, the little beak where these saucers meet (the upper beak strongly curved over the lower), the rounded head and thick body, the great strong clawed feet—such features are so well known that who would not recognise an owl on sight ? The plumage of owls is exceptionally soft and downy, so that their flight is soundless, and this, combined with the fact that they fly by night has made them seem mysterious creatures. As a matter of fact, owls like the daytime quite as much as the night, and have taken to night life simply because of the fact that if they fly by day they are set upon and mobbed by all the small birds of the air. Why other birds object to owls is not known : so *that*, at any rate, is an owl mystery. The fact that they have been driven to night work appears to have developed owls' sense of hearing and smell, which are very acute ; but owls are friends of man, and not creatures to be feared. They are friends of man because they feed upon rats, mice and voles, and other " vermin " that do so much to destroy our crops and stores. In the days when grain was always stored in large barns, an " owl hole " used to be left beneath the eaves, so that the birds could enter and feed upon the rats and mice that infested the store. In addition to rats and mice and voles, owls will eat other birds, and also insects, fish, reptiles, amphibia, rabbits, hares and gamebirds. Sometimes owls will kill and eat bats.

Of the five species of owl found in the British Isles the **Barn Owl** (*Tyto alba*) is the most common. Also called the screech owl, the white owl, the church owl and the hissing owl, its head, back, wings and tail are a boldly




mottled yellowy brown, its front being white : the edges of its " saucer-feathers " (round the eyes) may be brownish yellow. The long legs are covered with downy white feathers. The hen, who is larger than the cock, by an inch or so (she measures about fourteen inches), bears a number of dark specks on her breast. These owls spend the daytime in the shelter of barns, church towers, hollows of trees, holes in rocks, etc. Sometimes they will take up residence in dovecots, when they will not as a rule attempt to harm the smaller birds. They usually nest in the spring, but may do so at any time of the year. They may lay eggs at different times soon after one another, so that there may be half-grown chicks and new-laid eggs together in the nest ; but there is no constructed nest, the eggs lying in any little dip or hollow in the owl's hiding-place. The cocks help to feed the young.

The **Tawny Owl** (*Stryx aluco sylvatica*) has grey saucer-feathers, a dark black-and-brown mottled head, neck and back, with white feather-tips on the wings. The front is yellow with bold crosses or double crosses in black arranged all over it.

The **Long-Eared Owl** (*Asio otus*) and the **Short-Eared Owl** (*Asio flammens*) are pale-yellow-brown owls boldly mottled and gaining their names from tufts of feathers above the head on either side, which the bird can stick up at will.

## CHAPTER VIII

# PERCHING BIRDS

THE **Nightingale,** whose " tawny body and sweet small mouth feed the heart of the night with fire," has inspired many poets to a vast wonder at the glorious gift of melody possessed by many birds in the order *Passeriformes*, the " perching birds."

The nightingale sings during two periods only in his life. It is the cock bird alone who sings. He sings when he is love-making ; and he sings when the hen patiently incubates her five or six olive-brown or bluish-green eggs, and during that time he sings at his best, night after night, in order, so it is supposed, to draw any night-prowling enemy, such as a stoat, to himself, and in this way to protect his mate. For, possibly, the hen nightingale would not leave her nest though her life were threatened.

When the nightingale's eggs are hatched, he very rarely sings again until next season. All he utters are hoarse croaks as unlike the lovely liquid silver sounds he sang before as anything it is possible to imagine.

The nightingale is one of our summer vistors. We remember what that means : long journeys over land and sea, from Africa. Every year the nightingales begin to reach Britain early in April. As that very great naturalist, Gilbert White, duly noted : " Nightingale sings, April 1st." The nests will be ready early in May.

" There are three types of nest ; the first and most common is built on or very close to the ground, well concealed in the undergrowth, often among the previous season's dead leaves. The second type is built at the base of a sapling,

sometimes on the ground with very little cover around it, or at other times well concealed among ferns or brambles growing at the base of a small tree. The third type, and this is the most uncommon, is constructed from one to three feet above the ground in brambles or honeysuckle. The nightingale loves oaks, and if there is a row of two or three on the borders of its territory with thick undergrowth . . . then we are almost sure to find its nest within a few yards of the trees."[1]

The nightingales, like certain other birds, establish a sort of ownership over a small " territory " around their nest, and will fight other birds who invade this domain.

The nest is a cup of leaves set on their edges, with dry grass or horsehair in the centre. The leaves are in no way woven, and generally stay in position only because they lean against the sticks and twigs surrounding them.

The nightingale is not a showy-coloured bird. He is dull russet above, brightening somewhat towards the tail, and greyish white beneath. The bill and feet are brown, the eyes large and dark. Cock and hen are alike in plumage.

**Song Thrush** (*Turdus philomelos clarkei*). The song-thrush of Britain may not approach the nightingale in song powers, but he is a very sweet singer. " His loudest notes may be heard a mile away on a still morning ; his lowest sounds are scarcely audible at a distance of twenty yards . . . in spring and summer his loud carols may be heard from a tree-top at four o'clock or half-past three in the morning ; throughout the day he sings at intervals, and again, more continuously in the evening, when he keeps up an intermittent flow of melody until dark."[2]

The song-thrush, or throstle, as he used to be called, is a shy creature that skulks in the evergreens. He has a nut-brown back and a creamy black-spotted breast. He feeds mostly on worms and snails : he carries the snails to some favourite stone in order to smash their shells. The nest of

[1] Oliver G. Pike, *The Nightingale, its Story and Song*, p. 27.

[2] W. H. Hudson, *British Birds*, 1st edn., p. 42.


HEDGE SPARROW
ROBIN
BULL FINCH
WILLOW WREN
NIGHTINGALE
SPOTTED FLYCATCHER
MEADOW PIPIT
REED BUNTING
HOUSE SPARROW

the song-thrush is a thick-walled cup of dry grass and moss set low down in a hedge or bush, and lined with a plaster of mud or dung. In this are laid half a dozen beautiful blue eggs spotted with black. The cock bears some part in hatching the eggs, occasionally taking his turn on the nest while his wife goes off for a meal ; but the cock thrush will certainly not remain on the nest when you approach, and will indeed abandon it at the first threat of danger, unlike the brave and faithful hen.

The young song-thrush excels all other young birds in the wonderful freshness of his colouring—he has a glossy golden sheen about him which fades as he grows older. Two or even three families are raised during one summer, and often the young of the first family help in rearing those of the second, while those of the second help with the third.

There are many varieties of thrush. In Britain, the most numerous thrush, after the throstle, is the **Missel Thrush** or **Storm-Cock** (*Turdus viscirorus*), who is a larger and more handsome bird, with a deeper brown upon his back and bolder spots upon his breast. He is called the storm-cock because " he does not wait for a gleam of spring-like sunshine . . . but sings loudest in wet weather . . . a wild and defiant song, heard above the tumult of nature."

The missel thrush prefers to build his nest on some bough above reach ; but he does not build nearly so neat a nest as his smaller brother, and thrusts together a rough windbreak and platform made of all sorts of wisps and odds and ends—rags and sticks and grass—which can often be seen waving in the wind, an untidy mass.

The eggs of the missel thrush, however, are beautiful—greenish white or palest brown, spotted and blotched with orange and lilac. There are generally four or five eggs, and missel thrushes often raise two broods in a season ; and the missel makes up for his slack nest-making by his loyalty and courage in defending the nest. If any robber-bird approaches—magpie, jay, raven, crow, or hawk—the missels dash out to the attack, and scream and buffet with

their wings in a determined attempt to save their nest and young.

The name " missel " probably comes from the Anglo-Saxon word missel which means big : he is the biggest of the thrushes.

The thrushes belong to the same family as the nightingale, the *Turdidae*, which also includes the following birds :

**Blackbird** (*Turdus merula*). In Britain the blackbird probably comes next to the nightingale as a singer. But the blackbird is shy, and is sparing of his song. He sings only in the spring, probably to please the mother and babies. The blackbird sings his solos, as a rule, in a thick sheltered leafy place. (The thrush prefers a tree-top, where all the world can admire him for his vocal powers.)

The blackbird is a beautiful creature. " His bright yellow bill increases the effect of his blackness, and, like a golden crown, gives him a strange beauty. Like his companion of the garden and the shrubbery, the thrush, he is a skulker, and on the least alarm takes shelter under the thickest evergreen within reach. When disturbed from his hiding-place he rushes out impetuously with a great noise, making the place resound with his loud, clear, ringing and musical chuckles. But . . . you will sometimes find him on hillsides and open moors, or nesting in the scanty tufts of sea-campion on rocky islands where he has for only neighbour the rock-pipit. But above all situations he prefers the garden and the well planted ground."[1]

His food and his habits are like those of his brother thrushes—worms, insects, berries and fruit ; and like the thrush he can often be seen on the lawn " listening " for worms. Like the thrush, too, he takes snails and hammers them on stones to smash their shells. The nest is a deep solid cup of twigs, roots and moss, strengthened and lined with mud, with a floor-mat of dry grass and dead leaves, etc. It is usually built low down in a bush, hedge or low tree. The eggs are greenish blue, spotted and streaked with

[1] W. H. Hudson, *British Birds*, 1st edn., pp. 48–9.

varying shades of brown. From four to six is the usual clutch, but seven or even nine have been known. The cock aids the hen in building the nest and hatching the eggs. He is very quarrelsome, especially with other cock blackbirds, and for this reason two pairs of blackbirds rarely build near to one another. The hen has not the cock's bright shining black plumage, but is dark sooty brown. The young are also brown, but covered with spots, and their bills are black. Only when they have been adult some little time does the bill turn golden yellow and the bright yellow ring appear round the eyes.

**Robin Redbreast** (*Erithacus rubecula*). The hen robin is coloured like her mate, though her breast is not quite so bright a red as that of her husband. Young robins of the year are just little buff-spotted brown birds, very like miniature young thrushes. They get their red breasts in their first autumn, and then begin to fight among themselves. Probably no British bird is more of a fighter than robin redbreast. The robin likes holes to nest in, and will make an old bucket or shoe, a hole in a wall or a bank, his nesting-place. The nest is a cup of dead leaves and moss lined with hair. The eggs are about six in number, white, with pale reddish markings. The first nest is made early in spring and sometimes three broods a year are raised. The cock helps to feed the young. Their food is worms and insects, and large numbers of robins migrate south in the autumn, though many remain on our shores.

**Ring Ouzel** (*Turdus torquatus*). This bird has been called a blackbird with a white cravat, though his "black" plumage is really a sort of sooty brown. A migrant from the south, he arrives in England in April and seeks the moorlands and hills, where he builds his nest by the streams. His nest is very like the blackbird's, as are his eggs, which might be mistaken for a blackbird's save for their bolder markings. The ring ouzel usually hatches two broods. His food is the same as that of the thrushes.

**Redwing** (*Turdus iliacus*). The redwing is a winter visitor to the British Islands, its breeding ground being in northern Scandinavia, north Russia and Siberia. Migrating as far south as the Himalayas and north Africa, great flocks of redwings reach Britain in October. They return to the north about the end of March. Their plumage is very like that of the song-thrush, but with a white streak over their eyes, and the sides of the body and wings are reddish orange.

**Fieldfare** (*Turdus pilaris*). Also a winter visitor from the north, arriving earlier (September usually) and staying longer (sometimes until May) than the redwing. Very like a thrush, though without breast spots.

**Redstart** (*Phoenicurus phoenicurus phoenicurus*). With a white forehead, black cheeks and neck, orange-red front with white underparts, grey head and back, and orange-red tail this beautiful little bird is a summer visitor, arriving in early April, departing in September. Though not a common bird, he can be found all over Britain except in the south-west country, and parts of Scotland and Ireland. He is worth looking for, and easily recognised, not only on account of his bright plumage, but also because he perches on a tree and swings his red tail back and forth with a queer sideways movement. The hen does the same ; but she is not so brightly coloured : she has the same red tail, but a pale buff breast and white neck. A hole in a tree on the fringe of a wood, along a river, or in a park, is the spot selected for their nest, which is a loose structure of moss lined with hair in which are laid 5 or 6 eggs of a delicate blue colour. The hen alone sits on the eggs, but the cock is kept very busy feeding her with insects and other living creatures. He has a little rambling trill of a song. The young in their first plumage are spotted above and below.

**Whinchat** (*Pratincola rubetra*). About the middle of April the whinchats arrive from the south, and soon begin

to build a nest on the ground, either under a tussock of grass or in a sloping bank, loosely made of grass and hair. The eggs are 6 or 7 in number, very pale blue. The hen alone sits, but both parents look after the young. As soon as the first brood is on the wing, about the end of May, the parent birds busy themselves with the cares of another family, after which they wander about the open country until the end of August or mid-September when they take wing for the winterless lands of the south. The cock has head and back mottled in brown and black with a white face, save for a black tuft about the eyes ; a blue-black beak, a breast tinged with chestnut-orange on a white background, underparts white, tail brown-mottled with a few white feathers. The hen is paler and duller, the chicks being like their mother but with spots on the breast.

**Stonechat** (*Pratincola rubicola*). The stonechat is a lover of bushes, unlike his close relative the whinchat who likes the open fields. Wherever there is furze or tangles of bramble, there look for the stonechat—a black-headed, red-breasted, brown-mottled-backed fellow, with patches of white in each side of his head, in each wing, and over the dark brown tail. In early April you may find his nest beneath any thick bush, and, inside, the 6 or 7 pale blue eggs—rather greener than those of the whinchat—or perhaps you will find the 6 or 7 fledglings, rusty mottled brown, like their mother. The parents raise two families a season. These birds spend the winter amid the tangled bushes.

**Wheatear** (*Saxicola oenanthe*). " Our wheatear is a welcome herald of the spring, one of the first of the migrants to come back to the old home. It returns from the south in March and continues coming—wave after wave—until the middle of May. The wheatear always tells you it is there ; for as it nods to you from a stone, flirts its tail and flies restlessly hither and thither and back once more, it says *chack*, *chack*, over and over again in a very cheerful way.

Its note is like the stonechat's, but a little different, and the birds often frequent the same places. So the wheatear is sometimes called stonechat, which is a pity, for the two birds are very different in appearance."[1] An inch or so longer than the stonechat, the wheatear measures about 6 inches, and is a very handsome creature with a slate-grey head and back, white forehead, black cheeks, white neck and front, with a pale yellowish breast. The bottom part of the back is snowy white, the tail white also, save for the tip and the mid-feathers, which are black. The hen is brown instead of grey and black. The wheatears nest in mid-April in rabbit-holes, stone walls, etc., where they lay 4 to 7 pale blue eggs which are sometimes spotted with dark red-brown. They often raise two broods in a season.

**Whitethroat** (*Sylvia communis*). One of the commonest birds of the hedgerow, the whitethroat is a shy, cover-seeking creature who may at times be quite difficult to find, although about the end of April or the beginning of May, and again in September, when they are arriving from and leaving for the Mediterranean lands, they perch in great numbers on telegraph wires and trees. Cock and hen are almost alike, though the cock has a tinge of pink on his white breast. Head grey-brown, back a warmer brown, tail brown but white on the under-side : the wings patterned black and brown. The nests are made amid nettles, weeds and brambles under hedges : 4 to 5 eggs, greenish with lead-hued markings. Whitethroats generally raise only one family in the season. The Lesser Whitethroat (*Sylvia curruca*) is a slightly smaller bird, cock without pink on breast, back a shade lighter in colour. Wing markings not so plain.

**Blackcap** (*Sylvia atricapilla*). A handsome little bird with a jet black head, grey cheeks and neck, black back and tail, grey-white front. A summer migrant, arriving April, departing September. Not common. Nests in May and

[1] Sir J. Arthur Thomson, *The Outline of Natural History*, p. 324.


GREAT TIT
WREN
NUTHATCH
CHAFFINCH
GOLDFINCH
STONE CHAT

June in low, thorny bushes. Eggs are creamy white with yellowish-brown spots and streaks. The hen is a browner bird.

**Garden Warbler** (*Sylvia borin*). Olive-green head, back, wings and tail, bluish-grey neck, dusky-white front. Not common, though found a good deal in Lincolnshire. A summer migrant, coming May, leaving end of September. Nests in hedges. Eggs nearly white, marked in places with clouds of small dots.

**Wood Warbler** (*Philloscopus sibilatrix*). Found in certain woods in different parts of Britain, this summer visitor has a green back and yellow breast, white underparts : green and yellow tail, yellow above eyes ; a much brighter green than that of the garden warbler, the wood warbler is a gay little bird, but is not common in Britain. Nests in May in hollows on the ground or in dead bracken. The eggs are white with dark red-brown spots.

**Reed Warbler** (*Aerocephalus scirpaceus*). This summer migrant, coming in May and leaving in September is fairly common in reedy places in south and east England and in the Midlands. " He keeps entirely concealed by the reeds among which he lives, creeping along from one to another and assuming all kinds of strange attitudes. Now he hangs head downwards, or again, grasping a neighbouring reed with one foot, he will swing himself round and climb straddle-legged up two reeds, till on reaching the top he will perhaps take a short flight, only to dive in among the reeds again a few feet further on. The nest is a most beautiful structure, carefully supported on four or five growing reeds which pass right through its walls and thus hold it secure. For the size of the bird it is extremely deep, a wise provision to prevent the eggs from being rolled out when the reeds are bent with the wind. The materials used are dry grass, bents, and moss, with a lining of finer materials. The eggs, four in number, are pale green,

thickly freckled and mottled with a darker tone of the same colour."[1] He is a brown bird with a white throat, the hen having the same plumage as the cock.

Sedge Warbler (*Acrochephalus schoenobaenus*). Arriving late April and leaving end of September, this is a brown bird whose head and back are boldly mottled, wings and tail patterned in black and brown, front white with faint browny hues. A smaller bird than the reed warbler by an inch or so, the sedge warbler is usually about 4¾ inches. Nests in May in lower branches of willow or hollow in ground or in bushes : 5 to 6 eggs yellow-brown with darker spots.

Dartford Warbler (*Sylvia undata*). This exquisite British bird lives in varying districts of southern England and nowhere else. With a dark-brown-grey velvety head, back, wings and tail (the tail with a white stripe on each side), the neck, chest and underparts a warm chestnut-red, with bright red eyes, there seems no more stay-at-home creature in the bird world. He will rarely desert the common on which he was born in a nest well concealed in a furze bush. The eggs are whitish, very closely speckled with reddish brown. Two broods are often raised in the season. The hen is smaller, paler and browner than the cock.

Willow Warbler (*Phylloscopus trochilus*). With grey-brown head and back, dark wings barred with grey-white, a mist-grey tail darker at the tip, with pale lemon-grey front and white underparts, brown legs and feet, this migrant comes in April and leaves in September, and between those months is a common inhabitant of our woods, orchards, gardens and commons. In April or May the nests are made on the ground in long grass or below a bush or in a hole in a wall. The eggs are usually white, spotted with reddish brown.

Chiff-Chaff (*Phylloscopus collybita*). This bird is remarkably like the willow warbler, but can be known at once by

[1] J. Lewis Bonhote, *Birds of Britain and their Eggs*, p. 61.

the black legs and feet. The eyes are white with purplish-brown spots. In habits very like the willow warbler.

Gold-Crest (*Regulus anglorum*). This exquisite little bird is only 3½ inches long. The head is crowned with a lemon-yellow crest with tips of red in it. The rest of the head and the back are a light olive-green. The wings black and white and green. The tail brown-green and white. The throat is a blue-green, shading darker to brown-green over the breast : the underparts are whitish, legs and feet brown. The hen is duller with black streaks below the yellow crest. The gold-crest is not common, but some are resident among conifers, especially in yew-trees. Others are winter migrants, coming in large flocks in September and leaving in April. Yet other gold-crests are summer migrants coming in April, departing in September. The gold-crest is one of the smallest European birds, and its long and regular migrations may well be a cause for wonder. Unfortunately, most of the gold-crests we are likely to see at present are either summer or winter migrants, as the terribly severe winter of 1916–17 practically wiped out our native gold-crests, and they have not yet begun to dwell with us again in any numbers. However, the nest of any sort of gold-crest is well worth seeing, and many nests of migrants are to be found. This nest is a wonderfully neat hammock of moss, lichens and cobwebs, hung from the bough of a conifer, generally with the moss wound round the needle-leaves or twigs. In this, upon a lining of feathers, are laid 7 to 10 very tiny white eggs with reddish-brown markings.

Hedge Sparrow (*Accentor modularis*). This most common of all birds of the countryside has a very pale brown head, back, wings and tail, mottled and marked slightly with darker brown : the front is a dusky grey, the beak, legs and feet brown. The nests are usually in hedges, bushes, creepers or banks, and are made of twigs, moss and grass and lined with hair, wool, etc. The eggs, 4 to 5 in number, are generally plain pale blue.

**House Sparrow** (*Passer domesticus*). The house and tree sparrows belong to quite a different family from that of the hedge sparrow. The hedge sparrow is the last common member of the great family *Turdidae*; but, still keeping within the vast order *Passeriformes*, which includes several scores of families, we come to the important family *Fringillidae*, the family of the finches.

We are all so familiar with the house sparrow, who swarms in great numbers wherever man lives, that we are apt to overlook his good points. He is a far more showy bird than the pale brown hedge sparrow, having a blue-black head, a shining blue-black beak, a black throat with ash-grey cheeks and side neck, ash-grey front, a back boldly patterned in black and brown with a bluish tip and black tail : the wings, boldly marked in brown and black have a dusky white bar across. The hen bird is browner and duller, more like the hedge sparrow, yet more boldly marked than that bird. The house sparrows nest in April and May in almost any hiding-place. There are 4 to 6 pale bluish-white eggs marked with varying shades of ash-grey and brown. Two or three broods of young ones are produced during a season. In the country the house sparrow is often a serious pest, flocks of them settling in the cornfields and feeding on the grain.

**Tree Sparrow** (*Passer montanus*). The tree sparrow is very like the house sparrow to look at, but can be known at once by the fact that it bears two white bars on each wing instead of one, has a black patch upon the sides of the neck and a brown head. It is a shy and not very common bird that likes river-banks and canals where pollard-willows grow. As a rule it nests in a hole in a bank. The 4 to 6 eggs are smaller and more deeply marked than those of the house sparrow.

**Chaffinch** (*Fringilla coelebs*). Next to the house sparrow the chaffinch is the most common of the finches to be found near the homes of men. Like bullfinch, goldfinch, linnet and

several more, the chaffinch is a popular cage bird, though, since the Wild Birds Protection Act of 1934 it is no longer legal to catch wild British chaffinches, linnets, gold-crests, bullfinches, etc. When I was a boy we had, among many other birds, a chaffinch that sang with all the strength and sweetness and variety of note of the canary : it may have been trained so to sing, as many finches are. Although so well known, the chaffinch is worth a brief description. A black forehead and blue-grey head and pink cheeks and breast, a brown back, greenish on the lower half, a greenish tail with black feathers and white in it ; blackish-grey wings with two bars of white, underparts white, beak light : such is the gay and lively chaffinch. Not the least point of interest in the chaffinch is the nest, which is one of the neatest and most beautiful of nests, a mass of moss, grass and wool felted together with cobwebs and thickly lined with hair. Often the outside of the nest is overlaid by lichens which have been added by the builder the better to conceal the structure. The eggs, generally 4 in number, are greenish-blue, spotted and clouded with deep reddish-brown.

**Linnet** (*Linota caunabina*). The linnet is sometimes mistaken for a sparrow, but may be known at once by the white edge around the tail and the many white bars in the tail. During the nesting season, in April and May, the plumage upon the head and breast of the cock bird is of a bright red colour. The hen lays from 4 to 6 bluish-white eggs, spotted with red, in her cup-shaped nest of twigs and moss, which is generally built in a bush or shrub. Because of the sweetness of their song, linnets are often kept as cage birds.

**Twite** (*Acanthis flavirostris*). Sometimes called the **Mountain Linnet.** Chiefly a moorland bird, and can be known at once from the linnet by the yellow beak (the beaks of linnets are blue-black). Generally a browner bird than the linnet.

**Bullfinch** (*Pyrrhula nesa*). So-called from the stout build of his head and neck, the bullfinch has a black face and head, a scarlet throat, chest and belly, a deep blue-grey back with white near the tail and on the underparts, a black tail, and black wings with a clean white bar across them. The hen is marked the same, but where her husband is red she is yellowish. Both cock and hen sing, having a low flute-like note unlike that of any other bird. The hen sings only from the time the young can feed themselves until the autumn moult.

**Greenfinch** (*Figurinus chloris*). Sometimes called **Green Linnet.** This beautiful little bird is a practically uniform green throughout, though of a lighter shade on the underparts. The tail has two yellow streaks in it and is tipped blue-black, the wings have a yellow streak on the outer feathers and are barred blue-green and green-grey. The greenfinch nests in May where the branches are thickest in a bush : 4 to 6 eggs, whitish or pale greenish-blue spotted with reddish-brown and sometimes markings of pale violet or light brown. The hen is a much duller bird than the cock, almost brown.

**Goldfinch** (*Carduelis britannica*). An inch or so smaller than the average finch, the gay little goldfinch is usually about 5 inches. With a scarlet face, and white streaks on each side of it, a black crown, a chestnut back, a white throat, a buff breast, and white underparts, the goldfinch only needs the lemon yellow feathers set in the barred black and white wings, and the black and white tail and pink legs and feet, to complete such a splendour as no other finch can show. Although some goldfinches are resident in Britain most of those met with are migrants that arrive from oversea in April and leave in October. Their cup-shaped nest, made with moss and dried grass, and lined with feathers and hair, is built in a hedge or shrub or on the forked branch of a tree. From 4 to 6 greenish-white eggs are laid—they are spotted and streaked

with purplish-brown. Goldfinches are friends of the farmer, because they feed on thistles, dandelions and other weeds.

**Hawfinch** (*Coccothraustes coccothraustes*). The hawfinch is the largest of the British finches, his length being 7 inches. His plumage is a motley—chestnut head, blue beak, orange on sides of neck, light blue on back of neck, black throat, black round eyes and beak, orange breast, scarlet belly, yellow underparts, dark brown back, yellow-brown near tail, which is mostly pure white though with a black feather here and there. The wings have a wide white bar but are otherwise deep blue-black. The beak changes to pinky yellow in winter, and the hen is paler and less red. The hawfinch causes much damage in the kitchen-garden by ripping open pea-pods in order to feed upon the peas within, but the chief food of this bird is the fruit of the hawthorn. Four or five pale green eggs, decorated with dark spots, are laid in April in a nest made of twigs and lichen built in a tree or bush.

**Crossbill** (*Loxia curvirostra*). The finches and most other small birds have short peg-like beaks, but the crossbill receives his name because the two mandibles cross one another, in some birds the lower one overlapping the upper one, in other birds the upper one overlapping the lower. The young crossbills have straight beaks, and only as they grow up does this curious twist come over the beaks. The twist is to enable the birds to get the seeds that lie deeply buried among the scales of cones. Whether we should say this bird is common or rare I am not certain, because it seems to vary greatly, in some years many winter migrants arriving from the north ; but some are resident here. You will, of course, at once know the crossbill by his crossed bills. He is a salmon-pink bird with brown on the head, back and wings. Nests are made in February and March in long grass or bushes not far from conifers. Eggs grey or white with very varied streaks.

**Siskin** (*Carduelis spinus*). A north-England bird, also in Scotland. Black head. Green back and belly, orange tint in throat, yellow-and-brown barred tail and wings. Nests in April in high conifers. Eggs pale blue marked with red-brown and fainter red-grey. A beautiful singer, like canary : sings soaring above trees.

**Lesser Redpoll** (*Acanthis flammea cabaret*). Found in most parts of Britain, this bird nests mainly in the north and in Wales, in May, where it builds a neat structure of twigs and moss beautifully formed and lined with vegetable down, wool and feathers, in trees, bushes and hedges. Eggs like those of linnet, but smaller. This bird has a red cap, a touch of red on the breast and a tinge of pink above the tail, with a chestnut back, a black throat, brown wings in which is a faint bar of dull orange, and a very small, pointed and yellow beak.

**Mealy Redpoll** (*Acanthus flammea flammea*). Nesting in Arctic regions, this bird is a winter visitor to our east coast. Like the lesser redpoll, but a little larger and paler.

**Corn Bunting** (*Emberiza calandra*). The most common of the British buntings is the common or corn bunting, a bird very like a skylark and often spoken of as the " bunting skylark," though with a smaller and more peg-like beak than that of the skylark and without the skylark's topknot. It is also a smaller bird than the skylark. Nests in May in hay or low bushes. Three to six eggs creamy white with scrolls of dark brown.

**Yellowhammer** *or* **Yellow Bunting** (*Emberiza citrinella*). Although the corn bunting is reported to be our most common bunting, I have rarely walked through the country in any part of Britain without seeing at least one yellowhammer, and I have often failed to see a corn bunting in a long day's walk. Like the bullfinch the yellowhammer is rather a thickly built bird, with a rich golden

head, a gold-and-brown mottled back, a golden front that may be spotted with russet or red, and dark wings (brown-yellow or almost black), and a blackish tail with light yellow streaks. There is often a touch of green about him. The yellowhammer nests in April or May on or near the ground in hedge-bottoms, among gorse or in banks, lays 3 to 6 pale purplish-white eggs streaked with dark brown, with a few fainter violet markings.

**Reed Bunting** (*Emberiza schoeniclus*). This handsome bird is a resident in most marshy or reedy places. He has a black head with a broad white collar around the back and sides, a black throat, a white front and underparts, a brown mottled back and wings, a dark tail fringed with white. The hen has a pale buff front, a brown head and no white collar. The nests, built in April or May low on ground in marshy spots, contain 4 to 5 olive or pale green eggs streaked black-brown.

**Cirl Bunting** (*Emberiza cirlus*). Not common, this bird is a sort of mixture of yellowhammer and sparrow—yellow streaks above and below eye, yellow band below black throat—green mottled head, brown mottled back and wings, black and white tail, buff underparts. Eggs very like yellowhammer but with bolder markings. Nest like yellowhammer.

**Snow Bunting** (*Plectrophenax nivalis*). This, the rarest of our buntings, is also the most beautiful—a white, grey, and rust-coloured bird that visits our coastlands from the Arctic, coming in small numbers in September, leaving in May. A few nest on high Scottish mountains.

**Skylark** (*Alauda arvensis*). Of the family called *Alaudidae* but three species are common in our land, skylark, woodlark and shorelark. We need say little about the skylark, because everyone must know something about him, and most people know a line or two of poetry describing his

ascending flight and song. Yet all who know about him may not know him when they see him—a larger bird than all the finches and buntings, nearly eight inches of lemon-yellow and straw-brown plumage ; the front, yellow, flecked with brown ; the back, darker mottled-brown, with brown tail having dusky white edges. And do not forget to look for the mottled topknot at the back of his head. He nests in April or May, on the ground, sometimes in the middle of an open field where enemies great and small may at any time destroy the eggs or young—cattle may tread on the nest, field-mice may invade it. The hen lays 3 or 4 greyish, greenish or brownish-white eggs, mottled thickly with olive-brown and grey. These nests are made usually in April, but later in the season the parents may raise another brood.

**Woodlark** (*Tullula arborea*). To look at, the woodlark is very like a smaller edition of the skylark. His length is about 5½ inches. Like the skylark he sings on the wing, mounting ; but he does not fly so high as the skylark. Also, he often sings on a tree-perch ; and although skylarks often perch upon shrubs and trees, they sing only on the wing. The nests are placed under bushes, in March and April, the eggs are dirty white, spotted with browns and fainter greys.

The **Shorelark** (*Eremophila alpestris*) is a winter visitor to the east coast of England.

We next come to the family of the pipits and wagtails, called *Motacillidae*, one member of which, the pied wagtail, or water wagtail, we have looked at already in Book One, Chapter V.

**Meadow Pipit** (*Anthus pratensis*). The wilder moorlands and bleaker marshes are the haunts of the meadow pipit at all seasons of the year. Front, a pinky buff flecked with brown, back dark brown mottled. Nests on ground in April. Four to six eggs, greyish-white thickly marked with brown.

**Rock Pipit** (*Anthus spinoletta*). This species is very like the meadow pipit, but is slightly bigger and is found on the rocky coasts, never inland.

**Tree Pipit** (*Anthus trivialis*). The commonest of our pipits, the tree pipit is a migrant arriving with our other summer visitors about April. Very like the meadow pipit, but can be known at once by the white chin and underparts and white edgings on tail. The nest, placed in the middle of a field or bank, is made of roots and grass and lined with moss and hair. Generally six greenish-white eggs with blurred brown markings at their larger end.

**Tree-Creeper** (*Certhia familiaris*). This interesting little bird is common in woodlands throughout Britain. Belonging to the family called *Certhiidae*, the tree-creeper has a longish, down-curving, sharp beak with which it picks off tiny insects, on which it chiefly feeds, from the barks of trees, up which it climbs in jerks that remind us of the woodpeckers. It is a dull-coloured bird often hardly visible against the tree-bark, its back being mottled brown, front mist-white and dusky yellow. It nests at the end of April behind the loose bark of trees or in ivy or wall crevices. The 5 to 7 eggs are white with reddish spots at the end.

**Wren** (*Troglodytes troglodytes*). We had occasion to mention jenny wren, the smallest British bird, in the last chapter, where we described her wonderful covered nest.[1] She belongs to a family of passeriformes called *Troglodytidae*. There are several species of wren in Britain, some of them resident and some migrant : there are, for instance, the willow wren, the wood wren and the golden-crested wren. The eggs are white, more or less speckled with reddish-brown. Note the upturned stumpy tail of these birds.

**Flycatchers.** Of the family of flycatchers, called *Muscicapidae*, but two are common in Britain, the **Spotted**

[1] See under description of cuckoo, p. 426.

**Flycatcher** (*Muscicapa grisola*) and the **Pied Flycatcher** (*Muscicapa atricapilla*). Both are summer visitors. The spotted is a brownish mottled bird with greyish front, the pied a white-fronted black-backed bird with patches of white in the wings and a white star on the forehead. Both birds feed entirely on insects, which they catch on the wing, like swifts. The eggs are bluish, mottled and spotted with rusty red spots. Nests in ivy, on trees or under eaves.

**Red-Backed Shrike** (*Lanius colluris*). Summer visitor, chiefly to south and midlands, the shrike, which is a 7-inch bird, has a blue-topped head with blue on back of neck, centre of back being rusty red, bottom of back again blue, the splendid long fan-shaped tail patterned in black and white. The throat is white, the breast pink, underparts white. A feature to note is that the top beak (upper mandible) is longer than the lower and curves over the lower, to a point : this beak is blue-black. The nests are built in May in hedgerows or brambles and these birds are very faithful to the bit of hedge where they have once made a nest, as they will return there year after year. The nest is a neat affair of moss with woven stalks, roots, grasses, wool, etc. The eggs, 5 or 6 in number, are varied in colour and may be white, cream, pink, brown, green or blue ! The hen has a chestnut head, underparts and tail, and a buff front marked with black. The shrike belongs to the family *Laniidae*.

**Nuthatch** (*Sitta europoea*). A common bird in the midlands, east and south of England, rare in the west and north, the nuthatch is a tree-creeper of the family *Sittidae*. A long-beaked bird with a slate-blue-topped head, back and wings, a white throat and dusky-buff breast with a touch of orange, and buff underparts, the tail slate-blue with a flash of white and a patch of black. " Unlike the woodpeckers, which only run up the trees, it seems quite immaterial to the nuthatch whether he be going up, down, or sideways, forwards or backwards, for in all positions he seems equally at home . . . Insects are largely eaten in summer, but seeds, berries,

nuts and beechmast form his chief food. Nuts and hard seeds are taken to some convenient crevice in the bark and hammered with the sharp, hard bill until the kernel can be pulled out and eaten. Some hole in a tree or wall, or more rarely in a bank, is chosen as the nesting site ; the entrance is generally plastered up with mud till only a small round hole is left, just large enough to admit the bird. The inside is lined with a few leaves and scraps of bark on which are laid 5 to 7 eggs, boldly marked with reddish brown. These eggs bear a close resemblance to those of the great tit, but are, as a general rule, rather larger."[1]

We come next to the family *Hirundinidae*.

**Swallow** (*Hirundo rustica*). Who has not seen the swallows skimming low over the ground and noted that it was a sign of rain to come ? The swallows look like black and white birds ; but they have a patch of red on their forehead and throat, and their chest and underparts are cream-coloured. We need hardly remind the reader that the swallow is a summer migrant, since who does not know that " one swallow does not make a summer " ? Nor need we point out the " swallow tail " of this elegant bird. But the wings should be noticed—sickle-shaped wings, fine outer points, handsomely barred in cream and black. The habits of the swallow are very like those of the swifts, at which we looked in the last chapter. The 5 or 6 eggs are white, with red-brown or grey markings.

**House-Martin** (*Delichon urbica*). This summer migrant has a pure white front to his very feet, his legs being white-feathered. His head is black, his back being black until half way down, then white to the tail, which is black. His tail is forked, like the swallow's, but is not so long ; and his wings are much the same shape as the swallow's, but not so finely sickle shaped, being broader : they are black. Martins nest at the end of May in the eaves of houses and in holes in walls. The 4 or 5 eggs are white.

[1] J. Lewis Bonhote, *Birds of Britain and their Eggs*, p. 82.


SWALLOW
HAW FINCH
RED BACKED SHRIKE
STARLING
SKY LARK

**Sand-Martin** (*Riparia riparia*). A brown head, back, tail and wings, the wings barred with black, this is the earliest of the *Hirundinidae* to arrive on our shores. A white throat, chest and underparts, with a touch of brown on the chest. These birds tunnel out their nests in chalk sea cliffs, in sandy banks, etc., and lay their white eggs from May onwards, sometimes nine feet in the cliffs.

Of the tit family, called *Paridae*, there are five common British resident species, and several local species, such as the crested tit which is hardly ever found outside the Spey Valley in Scotland.

**Great Tit** (*Parus major*). This gaily coloured bird has a black head and neck and white cheeks ; his sides, beneath and in front of the wings are light green ; in front his black neck goes down like a tucked-in black scarf, to the underparts. Below the black scarf, at the back of the neck, a white patch shows : around and below this patch the darker green of the back spreads down to the blue and green tail. The wings are blue, barred in both directions with white, and with an area of black feathers in the centre. The great tit is a woodland bird, but can often be found in orchards and gardens. Like all the tits he is an expert tree-creeper and clinger. Nests in April in holes in walls, trees, etc. Eggs 5 to 11, white, spotted with shades of red-brown.

**Long-Tailed Tit** (*Acredula caudata*). Found in much the same places as the great tit, the long-tailed tit is a very different-looking bird, with its tail as long as its body—a straight, narrow tail with a rounded end, black, fringed with white—and in colouring, too, it is quite unlike its near relative : white head, throat and breast, pink underparts, black and white wings, black back. Nests in April in thorn, holly, furze, ivy or lichen-clad high branches of trees. The cock builds the nest, which is perhaps the most elaborate bird's nest in Britain, a solid, thick-walled egg-shaped, domed-in building, covered with lichens which are woven into the structure by means of cobwebs. The inside is lined

thickly with feathers and horsehair. At least 10 eggs are laid—they are white, spotted with light red. The long-tailed tit lives entirely on insects, and so does not merit the war which is waged by man against several of the tits that do so much to destroy the fruit buds in our orchards.

**Coal Tit** (*Parus ater britannicus*). Head and throat black, with large white patch on side and at back of head and neck. Back grey-green, brownish near tail, which is blue-green with blackish feathers. Breast whitish, underparts brownish. Wings blue-black, faintly barred white. Nests in April in tree-stumps or holes in walls or hedge bottoms. Seven to eleven eggs, white with red spots. This bird is not found outside Britain.

**Marsh Tit** (*Parus palustris dresseri*). Found only in England and Wales, the marsh tit is extremely like the coal tit, the tail and wings being generally darker. Eggs and nests the same as coal tit.

**Blue Tit** (*Parus coeruleus*). Sometimes called Tom Tit. Very like coal and marsh tits in habits, even the nests and eggs being extremely similar, the blue tit is very different in appearance, with his white band around the blue crown of his head : his black band below the white band, the white triangular cheek patches below this black band, and the black scarf around his neck below the white patches. Below the scarf, his breast is yellow to the underparts, which are black, then yellow. His back is green, his wings are blue with a straight bar of white across, and several curving bars of white along. The tail is blue.

**Bearded Tit** (*Panurus biarmicus*). This is a member of a different family from the true tits. Belonging to the *Panuridae*, the bearded tit is rarely found outside the Norfolk Broad district. Blue head, black marking on cheek and neck, brown back, white front, brown, black and white wings, the bearded tit has a very long brown, black and white tail.

**Starling** (*Sturnus vulgaris*). The starling is one of our most interesting birds. A largish bird, $8\frac{1}{2}$ inches, with a long pointed beak, arrayed in a glittering black plumage that gleams with dull red about the head and neck and with green over most of the rest of the body, with tints of brown in wing, back and tail. The nests, built in April, are made in any hole in a tree or wall, the roof of a house, drain-pipes, church towers, cliffs : an untidy nest of straw, grass and rubbish with a few feathers or bits of wool as lining. Five to seven pale blue eggs form a clutch, and two broods are reared in the season. When the young leave the nests they soon gather with the young from other nests and soon form the beginnings of those vast flocks which are one of the specialities of this species. Over no bird, perhaps, have the farmers argued so hotly as over the starling. Is he a pest, or a servant of man ? "Perhaps the time when we most warmly appreciate the efforts of the starling is when the oaks are being defoliated by the caterpillars. . . . In May and June the birds, young and old, fill the tree-tops with wheezy clamour as they fill themselves with the swarming caterpillars. . . . In summer and autumn, when fruit is ripening, we see quite a different picture, for in the orchard the bird is not merely destructive, it is shockingly wasteful, tasting and damaging far more than it devours, eating the ripe pears near the stalk until they drop with their own weight, to be finished on the ground by slugs and wasps. Pears, apples, cherries, plums, all suffer, and in the field wheat is eaten."[1] For all that the starling remains a popular bird, since he is fearless and amusing and has almost a parrot's powers of mimicry. His family is called *Sturnidae*.

From the family *Sturnidae* we pass on to the great group in the family that is thought to be the most highly developed of all birds, the *Corvidae*, or crow family.

**Jay** (*Garrulus glandarius*). The jay is a bird of great beauty, but he is also a thief and a murderer, a robber of

[1] T. A. Coward, *Bird and Other Nature Problems*, p. 4.

small birds' nests, particularly those of thrushes and blackbirds. But "set a thief to catch a thief": the jay has no more deadly enemy than the sparrow-hawk, who fills him with dread. The jay is not a good flyer, and fears the open. When he is afraid he chatters and warns all other birds of the presence of the hawk—or of fox, dog, stoat, cat, man, or any other enemy of the wild birds. Nothing can move in winter without the jays setting up their "squawk ! squawk ! squawk ! squawk !" And in spring, if you are lucky enough to espy a jay's nest and climb up to it, though you may never see the jay, you may be sure the jay sees you, for she always keeps a watch on the nest. If there are eggs in the nest, in all probability after you have gone the jay will return and piercing the eggs with her beak will suck out the yolk, thus gobbling up her unborn children. She fears to raise a brood in a nest which has been in any way disturbed, and rather than leave the eggs for some other marauder (perhaps for her enemy, sparrow-hawk), she will devour them herself, and will construct another nest elsewhere.

There may be four to seven eggs in a jay's nest—greenish-white eggs, closely freckled with light olive spots. The nest is placed in a tree or bush. The nest is a large, deep, neatly built cup of twigs, larger twigs outside, finer ones within, with a lining of rootlets. Cock and hen share the patient work of sitting on the eggs, which hatch out in April and May. There are resident jays in Britain, but many come here in autumn from across the North Sea. The plumage of the jay is a dull glowing red, with vivid blue-and-black-striped wing feathers, and flakes of white in the tail.

**Chough** (*Pyrrhocorax graculus*). This member of the family is now very rare indeed, having almost been driven out of the country by his great rival, the jackdaw, and by man. The chough is still sometimes seen, however, in the south-west corner of England, notably in Cornwall. The black plumage, bright red legs and red curved beak, make him fairly easy to observe.

**Jackdaw** (*Corvus monedula*). It would probably be hard to find in Britain an old church tower or ruin uninhabited by jackdaws. Like the robin, they build their nests in holes ; but, unlike the robin, any old tin can or hole-in-a-wall will not do for master-builder jackdaw. He likes space, and some of his nests are veritable skyscrapers. Great piles of sticks twelve feet in height, piled up by jackdaws, have been found in ancient towers—though they do not restrict their building material to woodland sticks, as anyone can tell who has read the *Jackdaw of Rheims* (which will remind us also that the jackdaw gathers material not merely for building). The jackdaw has a bad name for pilfering, though, as a matter of fact, he is not a bad sort of bird. He is a great destroyer of injurious insects and has the useful habit of ridding sheep of some of their parasites.

In wild life the jackdaw nests in hollow trees and cliffs. His eggs are very pale blue, almost white, marked with bold dark spots, almost black, and there may be any number from three to eight in a clutch. The birds nest late, in May or June, and have one family in a season. Jackdaws often keep company with their brothers, the rooks, when flying and foraging, and they are not unlike rooks in their general appearance, being, however, smaller, with shorter bills and a pearly white eye, in great contrast to the large dark orb of the rook.

**Rook** (*Corvus frugelicus*). These great birds are very different in habits from the jackdaws. They build colonies of nests in the tree-tops in March and April, and the chorus of their " cawing " in the rookeries is a constantly recurring sound to every traveller through the English countryside. From the ground, looking up at a rookery, the nests seem to be very rough-and-ready ; but they are as strong and well-made as any nests in the bird world, and outlast the storms of winter, being repaired if necessary every spring. They are open and cup-shaped, made chiefly of twigs, which the birds often pull from the trees. These twigs are woven together and cemented with mud, the floor of the nest

being lined with such stuff as hay and straw. Sometimes a pair of birds will start stealing material from another nest in the rookery, and this causes trouble. It is probably the chief cause of those rowdy quarrels one can sometimes hear going on among the rooks in the tree-tops—" fierce prolonged scrimmages . . . six or seven birds struggling together on some particular nest of the rookery . . . fighting with wings, beaks and claws." Both birds help each other to build the nest, and while the hen is sitting on the eggs, the cock feeds her. All the members of the family *Corvidae* tuck food under their tongues for feeding their mates and their young. The food of the rooks is chiefly worms, insects and slugs, in autumn acorns, seeds and grain, in winter, nearly anything they can get.

A great strong handsome bird is the rook, with a glossy purple sheen in his black feathers, and a longish stout bill protruding from a face bare of feathers.

Magpie (*Pica pica*). The magpie is a little smaller than the rook. He is a notable architect, and as a rule builds his nest in a tall tree in or on the borders of a wood. The nest is large, formed of sticks and mud, and lined with fibrous roots, and over this solid platform and nest the magpie builds a roof—a great dome of interwoven thorny sticks. In the side of this veritable basket is a door—a hole just large enough to admit the bird. This home may serve a pair for many years, such repairs as are needed being attended to in the spring, before a new breeding season begins. The eggs are usually six in number, but sometimes as many as nine are laid. In colour they are pale bluish-green, very thickly speckled with olive-brown spots, and faintly blotched with ash-colour.

The magpie is one of the most splendidly plumed birds in the north temperate zone, though its lovely feathering is worked out mainly in black and white, with certain gleaming tints of colour. With black back, and pure white shoulders, black wings, the upper half of the breast black, the lower part snow-white, it would be striking enough ;

but a great spread of tail springs like a long-shaped fan from the base of the back, and this tail, of deep black feathers, is so constructed that it shimmers with refracted colours of green bronze and purple. We have seen that refracted colour is produced like the blue of the sky by light-waves being deflected ; and the fine feathers on the great spreading tail of the magpie produce these gleaming colours. The scale-wings of many insects dazzle us with refracted colour of this sort, and the tints of the pearl oyster occur from the same cause. The minutely fine fibres of the feathers are the cause of the colours in the magpie's tail.

The magpie feeds on grubs, worms, snails, slugs and various insects, on carrion (dead bodies of birds and beasts), and on ripe fruit ; and he will devour young birds and eggs. He is not, however, so feared by the smaller birds as is his dreaded black brother, the carrion crow.

**Carrion Crow** (*Corvus corone*). "He is a murderer, ruthless as Fate, and the most that can be said for him is that he is faithful to his mate, like the raven, and faces life cheerfully. I always fancy he laughs out loud when he sees a keeper with a gun. He always calls out his hoarse ' ha ah ! ha ah ! ' on such occasions. He must have a curious sense of humour, because there seems very little for him to laugh at. He is Ishmael, an outcast. Every man's hand is lifted against him, and in return he harries all creation. . . .

" From March until July crows prey incessantly on other birds, their young and eggs. You can see them on the hunt for eggs all day in the early spring, followed by peewits and other birds, who shriek wildly and try to drive them away. . . . They merely dodge, and calmly go on with their search."[1]

The crows are solitary birds, nesting in scattered pairs in April. They are fond of high, inaccessible places, such as cliff-tops ; but they are not particular, and will set up their homes in trees, or even on the ground. These huge birds

[1] H. A. Gilbert and Arthur Brook, *Secrets of Bird Life*, pp. 94–5.

—twenty inches from beak-tip to tail—are strong and fierce and feel able to defend themselves against any foes. The cock aids the hen to build the nest, and to hatch the eggs and feed the young. There are four or five eggs in one clutch, and they are very similar to the rook's.

Among other species of crow we may mention the **Hooded Crow** (*Corvus cornix*), who is an inch or two smaller than the carrion : a grey crow, with head, wings and tail black.

**Raven** (*Corvus corax*). The *Corvidae* family is supposed to be the most highly developed family of birds ; and of that family the raven is supposed to be the most intelligent. He is the largest of all birds in the order *Passeriformes*, being a full twenty-five inches in length. The hen is rather smaller than that.

He is, of course, normally black. Indeed the raven looks like a larger edition of the carrion crow ; but white ravens are not unknown—King Charles II used to keep one in St. James's Park, and in the Faroe Islands black-and-white ones used to be quite common. White blackbirds are by no means rarities and may occasionally be seen in many parts of the country. But to return to the raven. He nests in cliffs and crags and lives noisily in great numbers. Like the carrion he is a terror to all smaller dwellers in birdland. He is now very rare in Britain, though you would think that a bird who lived such a long life would not easily become rare. Ravens may live to be seventy, though this is not a record among birds. Parrots have been known to top the century mark, and eagle-owls have lived as long as ravens. Next in the scale come condors and eagles, who can live to a respectable half century or so.

Among the smaller birds it is believed that ten years is a ripe old age, though robins and song-thrushes sometimes carry on for twelve to fifteen years. Birds in captivity generally live longer than those in a wild state—this is true, at least, of small cage birds, such as finches.

With the raven we come to the end of the vast order

*Passeriformes*. Of course it has not been possible to mention all the passeriform species that may be found in Britain, but we have given some account of every kind reported "common" and of many not so common or "local." Before we leave the realm of the birds we must glance at just one more bird, not a passeriform, but a member of the accipitres, the order of the birds of prey. There are several species of this order to be found in Britain, all of them belonging to the sub-order *falcones*, the falcon group, which includes the eagles, buzzards and kestrels.

**Sparrow-Hawk** (*Accipiter nisus*). The hen sparrow-hawk is larger than the cock, being fifteen inches, while he is thirteen. He has a bronze mottled front, a slate-grey head and back, tail brownish with dusky bars. She is a lighter-coloured bird, with head and back brown-grey, and tail barred, front pale yellowish-white mottled brown. They have the top beak curving over, typical of birds of prey; and, though they have all the swiftness in flight of a bird that lives by seizing other birds and mammals, the wings of the sparrow-hawk are very short in comparison with the body-length—a mere eight inches each. They nest in April or May, generally in an old crow's or pigeon's nest, which they repair, the cock helping in everything. The eggs, of which there are generally four to six, are bluish-white blotched with rich chocolate-brown.

This, then, is a bird feared by the rest of the bird realm; though the sparrow-hawk by no means restricts himself to a bird diet, and will eat almost any living animal—frogs and small mammals, for instance. A fierce creature, much given to lurking at the edge of a wood, and pursuing its victim, with the speed of the wind. When a creature has been seized in the strong talons, the sparrow-hawk spreads drooping wings over it and kills it on the ground. It will pluck a bird of its feathers before eating it, and it keeps a larder of its victims near its nest.

# CHAPTER IX

# MAMMALS (1)

## (*Chiroptera, Insectivora and Rodentia*)

CERTAIN MAMMALS have conquered the air even more completely than birds have done.

Bats are considered to be better flyers than birds. They can change their speed almost instantaneously in the air, stopping suddenly and diving and somersaulting and soaring again, in the space of a few seconds. Their aerobatics would be the despair of any airman.

Bats are difficult to watch, being nocturnal. Most of the species in our land live upon night-flying insects, such as moths and mosquitoes. As a rule bats drink while on the wing, like swifts and swallows ; but they can sometimes be seen landing beside a pool or stream, to lap up water.

To many people, bats are hateful creatures. Because they live upon insects they are probably of as great service to mankind as are any of the birds.

Bats are built upon a very different pattern from that of birds. The name of their order, *Chiroptera*, means the " wing-handed " animals. We saw that a bird's wings are really forelimbs, with a feather-structure attached, and that birds have the tiny remains of two or three fingers at the tip of these " arms." The bats also have long forelimbs, but the fingers of their hands are so drawn out as to be longer than their forearms, and the middle finger is at least equal in length to the head and body combined, whilst the thumbs are short and stumpy, and each is provided with a claw. Their feet also have claws with which they climb and cling.

Between the long bony fingers of the bat stretches a web of skin so thin that, when I place it between my thumb and forefinger, it seems to me I am holding my thumb and forefinger together with nothing between them. This web of skin is a sort of wing-plane on which the bat flies ; and it is attached to the insides of the bat's arms, and to the sides of his body, down to his tail, and sometimes is attached to the tail on both sides to the very tip. This wing-plane is also fixed to the sides of the bat's two short hind limbs as far as his feet, so that he has a wing-plane of the finest possible texture stretching on each side of him from finger-tips to feet. The stumpy thumbs are free from this wing-plane and are used by the bat for climbing.

The time to catch bats is during the day, when they sleep, often congregated in great numbers, in dark places such as caves, under roofs, in cellars and old barns. In spite of their savage-looking features they are timid and harmless creatures.

Unlike a bird, a bat is a toothed animal. If we except certain barbs and spikes possessed by a few birds in their beaks, such as the little backward-pointing hooks in the beaks of the puffins by which they bring home small fish for their families, no bird has anything approaching a tooth in his head. The bats are further distinguished by the possession of remarkable ears, whilst the noses of some bats are developed into delicate organs of perception which may serve much the same purposes as the antennae of insects. These are called " nose-leaves." The bodies of bats are covered by hair. Hair is found nowhere in the animal world except on mammals.

We have in Britain twelve different species of bat. These belong to several genera. The genera of British bats in turn belong inside two families, the family of the simple-faced bats, *Verspertilionidae*, and the family of the horse-shoe-nosed bats, *Rhinolophidae*.

**Noctule Bat** (*Nyctalus noctula*). Also called the Great Bat. The head and body of this bat measure about three

inches, the tail is just over two inches : the tail of the noctule is not attached to the wing-plane and hangs free. The largest of British bats, the noctule is also the swiftest flyer, and often flies at great heights, sometimes in company with swallows. A point to note about all bats, however, is that although they are more expert flyers than are birds, they cannot fly for anything like the same length of time. Most bats remain on the wing, hunting for their food, all night long ; but they have to keep taking short periods of rest. The noctule bat hunts twice during the night : he starts off just after sunset and flies for one and a half to two hours, then rests until a couple of hours or so before dawn, when he hunts again until sunrise. He swoops down on the night-flying insects and eats them on the wing. The fur of the noctule is of a yellowish colour, almost golden. This bat lives amid trees, spending his days in hollows in the wood, only very rarely in old barns and houses. Unlike most bats, the noctule has never been found in caves. Like most bats, the noctule hibernates. Like the dormouse, which we shall observe shortly, the bat " tucks in " with a vast meal in the autumn, becoming extremely fat. When the first cold of autumn sets in the bat finds a winter retreat, hangs up and goes to sleep. Bats hang up in a curious manner. Having to hang by their foot-claws, head downwards, most bats catch their perch with their thumb-claws then draw up their feet and let go with their thumbs. There they hang through the long winter months, and it is an amazing fact that, despite the big last meal they have eaten, their body-heat soon falls to about the same temperature as that of the air surrounding them, like the body-heat of reptiles and fishes : their breathing gets slower, their heart-beats weaker, and they turn pale. In spring, with the first warm days, a sudden change comes over the sleeping bats. In about a quarter of an hour their temperature rises as much as thirty-one degrees, their breathing and heart-beats become rapid, their skin goes rosy-pink, and they are ready for an active bat-life. But how thin they are ! Mere shadows of their former selves—until one or two good meals have been

eaten. Baby bats are born in June, July or August : there is usually only one, though twins and triplets are not unknown. The babies are hairless, and they hang on to their mother's fur by means of their claws. For five or six days they are blind. For ten days or more the mother never leaves them, and, like all mammals, they live by sucking the mother's milk. After ten days or so the mother will go off for short times to feed, but will take the young under her wing when she returns. Not until they are two months old can the young bats take other food than their mother's milk. During that time they have special teeth, called milk teeth. When they are a month old they begin to lose the milk teeth and get a second set of grown-up teeth with which they can bite up insect food. So little is known about the British bats that no one yet seems to have watched their family life.

**Leisler's Bat** (*Nyctalus leisleri*). A rare species in Britain, seen only in Cheshire, Yorkshire, Norfolk and Somerset. Like the noctule in form and in habits, but much smaller and rather darker in colour.

**Pipistrelle** (*Pipistrellus pipistrellus*). A brown-haired bat, the front a lighter brown than the back and head. The smallest British bat, the pipistrelle is sometimes known as the **Common Bat** because it is found in every county of Britain wherever bats can exist : even in crowded city streets it is not unknown. Everybody has probably seen the flitting body of the little inch-and-a-half-long pipistrelle. In spite of the small size of this bat, the wing-plane when opened measures over eight inches. A flat, broad head and wide mouth, short, broad ears, triangular in shape save for the blunt tips, the last joint of the inch-long tail is free from the wing-plane and is *prehensile* : that is, it can be used by the bat for coiling round objects, to assist in clinging and climbing : this bat utters shrill little squeaks as it snaps up insects.

**Serotine Bat** (*Vespertilio serotinus*). Almost as big as the noctule, the serotine bat is found only in the south of England, and is deep brown in colour, though rather lighter in front. It has a greater length of tail than the noctule. Generally flies for about an hour each evening.

**Water Bat** (*Myotis daubentonii*). So called because it is nearly always found hovering over water, where caddis flies form its staple diet; it is also called **Daubenton's Bat.** Found throughout England, Scotland and Wales wherever there are woods and water, this bat lives largely in trees and caves, sometimes in buildings. The colour is warm brown, but the tips of the hairs are lighter than the bases of the hairs, which gives the bat a grizzled look. Rather larger than the pipistrelle, but still a very small bat.

**Natterer's Bat** (*Myotis nattereri*). Also called **Red-Grey Bat.** This common bat is about an inch and three quarters in length, being slightly larger than the water bat. The tail is an inch and a half. Easily known by its colour, the back being greyish-brown, the front whitish, Natterer's bat has a fringe of hair below the ears, which is found in no other bat. When pointed forward these ears reach beyond the tip of the nose. Generally found in wooded places, where it flies low and keeps up a high-pitched chattering noise.

**Whiskered Bat** (*Myotis mystacinus*). Slightly larger than the pipistrelle, the whiskered bat can be known at once by its hairy face, its small eyes being almost hidden in the fur. It is light yellowish-brown on the back, grey-white in front. The whiskered bat hunts among the branches of trees, snatching insects from the bark.

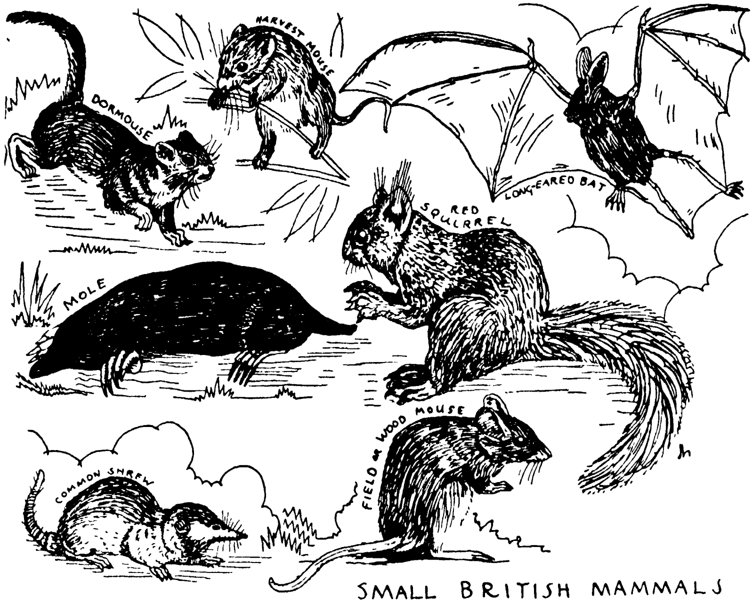
**Long-Eared Bat** (*Plecotus auritus*). The ears of this bat are about the same length as its head and body together, about two inches. They are oval in shape and semi-transparent, and in order to be protected while asleep these long and delicate ears are carefully folded away beneath

the wings. The fur of this bat is long, soft, thick and silky, brown on the back, white and yellowish on the front. The long-eared bat snatches its food from the leaves and branches of trees, though sometimes hovering near the ground, seeking grass-loving insects.

**Barbastelle** (*Barbastella barbastellus*). With a head and body of about two inches, and a tail of an inch and three quarters, with long soft fur, dusky and black, most of the hairs having white tips, this bat can never be mistaken for any other British bat, because the two ears are joined together near the top of the head. The curious, ugly face of this bat has swollen cheeks on which grow tufts of black bristles. The face has deep grooves in it.

In spite of the last mentioned bat, all the above bats belong to the family called simple-faced. We get real queer-looking creatures when we come to the two British species of the *Rhinolophidae*, the family of the horseshoe-nosed bats.

**Greater Horseshoe Bat** (*Rhinolophus ferrum-equinum*). Found only in the south and west of England and Wales, this bat bears in the middle of his face a triangular pile of crumpled-looking dull-grey flesh. This is the *nose-leaf* to which we have already referred. The bottom part of the nose-leaf is shaped like a horseshoe, in the centre of which lie the nostrils, sunk in a hole. Above this rises a horny pyramidal sort of thing, and above this again rises a tongue-shaped piece that comes to a point in the middle of the bat's forehead. On each side of this nose-leaf lie the little black eyes, almost buried in the thick soft wool-like fur of dull brown. This fur covers the entire body of the bat. Living to a large extent on flightless insects and spiders, the greater horseshoe bat flies low, near the ground. Horseshoe bats do not really hibernate, but are more active during the warmer months. They do not eat their prey while on the wing, but take their captures to definite "dining places."




**Lesser Horseshoe Bat** (*Rhinolophus hipposideros*). Perhaps we should mention here one of the most remarkable things about bats in general—the way in which they can fly in complete darkness without hitting anything, twisting and turning silently through the mazy branches of a wood, pursuing their prey in the blackness. No British bats are more skilful in the air than the two horseshoes, who seem to he helped by their ugly but mysterious nose-leaves. The lesser horseshoe bat is smaller in size than the greater, otherwise very similar and found in the same parts.

Although living entirely on insects, and therefore called insectivorous creatures, the bats are not included in class **Insectivora** of the phylum Mammalia. The order of the insectivora is represented in Britain by hedgehogs, moles and shrews.

**Hedgehog** (*Erinaceus europaeus*). The body of the hedgehog and the place where he lives are well described

in his name: hedgehog, "the pig of the hedge." This animal has a head and snout that are very like those of the farmyard pig. The fat round body that touches the ground as the hedgehog walks along on his short legs also serves to remind us of the porker; but there the resemblance stops. The little stumpy tail is covered by hairs on the under-side and is skin-naked on top. The head, face, under-side and legs of the hedgehog are covered with dull brown or grey-white hairs. From the back and sides spring a thick coating of stiff, sharp-pointed spines. These spines are light coloured with a dark band round the centre of each. They are as keen-pointed as bayonets, and are hard, but will bend, and are not easily broken. They are fixed firmly into the leathery skin of the animal. Under the skin there is a series of special muscles which enable the hedgehog to prick up the spines until they form a perfect protection against a world of foes: usually when attacked or alarmed the hedgehog tucks his head in between his back legs, and pricking up his spines, makes himself into a ball of spines, a ball which has no opening through which the little curled-up pig within can receive any hurt. These spines can be laid down flat along the back and sides when the hedgehog wills, and in this position the animal can safely be stroked. The eyes of the hedgehog are bright, and are big for his size: his head and body measure together just over nine inches, the sow being less than an inch smaller than the boar. Their feet have five toes, each with a claw, and five pads on the sole of each foot; their ears are rounded and upstanding.

Such, then, are the hedgehogs who search along hedge-bottoms, and in ditches and dells for the insects on which they mainly live: besides insects they eat snails, slugs, etc., and they will also kill and eat rats and mice and even rabbits. Hedgehogs are not easy animals to watch, since they live by night. As a rule hedgehogs have two families a year, one born in May or June, and one in August or September. There are usually 5 to 7 babies—blind and covered with soft, movable spines. The hedgehogs make no home for their young, but may choose a rabbit burrow

or some hole in an old tree. In such a place, too, hedgehogs hibernate. Collecting leaves, grass, sheep's wool, and other warm stuffs, they will eat enormous meals in the late autumn, growing vastly fat, and when the cold sets in they will lay them down in the softly-lined bedroom, not to wake until the buds are on the trees and the summer migrants among the birds are already at work in the woods. By this time, you see, the insects are astir again ; and in spite of the occasional rats, mice and rabbits, the real food of the hedgehogs is—insects.

Mole (*Talpa europaea*). The mole is not only one of the most curious wild animals in Britain, but is also one of the most interesting wild animals in the world. We have learned nothing from this book if we have not learned by now that a masterly fitness is seen in the varied ways in which the creatures of earth have adapted themselves to their varying environments—the birds with their air-filled bones and their warm feather coats : the insects that have egg-laying swords that pierce the skin of caterpillars or plunge their tiny eggs beneath the soil : the fish that have fins to balance them and tails to guide them, so that they can swim 50 and 60 miles an hour and can cross the world in the calm depths beneath the ocean's troubled surfaces ; these and a hundred forms of adaptation we have seen, enabling creatures to make a special environment their home. Each creature has " made a virtue of necessity," and has mastered his particular habitat.

Perhaps no creature on earth is more perfectly fitted to the life he leads than the humble mole of our countryside, nor has any animal more completely mastered the little bit of earth on which he lives. Few people, I suppose, have ever seen a mole ; but few people, I imagine, have not at some time tripped over a molehill ; and if you think of the number of molehills you have seen you may gain some idea of the number of moles you have not seen. The mole population is a very numerous one indeed.

The mole lives upon earthworms, and everybody knows

that in pursuit of earthworms the mole makes tunnels underground. The mole, as a matter of fact, can make a tunnel 100 yards in length in a single night—an amazing feat for a creature six inches long ! He not only can do this, but frequently does. Moreover, he makes labyrinths of tunnels, with long series of main tunnels and branch tunnels. The most extraordinary of these underground mazes are those called moles' fortresses, which are impossible to describe in brief; but which may be said to consist of a sort of central cave, quite large in size, in which the mole builds a nest of dry grass. From this central cave tunnels run out in all directions, often for great distances. These mazes are, so to speak, the winter residence of the mole, who uses them from September until early summer of the following year. The nest in the central cave is a sleeping place, not a nursery for the young.

When the young are about to be born, in March or April, the female builds a breeding nest for herself quite apart from the fortress, and there the 3 to 6 young moles are born. They are born blind and hairless, and in about five weeks they are three quarters grown and are able to move about and fend for themselves. It is a year before they are grown up.

As we have hinted, the fully grown mole is a marvel of adaptation to his environment. His tiny body is long and slender—perfectly fitted for life in tunnels. His snout is long, pointed and movable : this snout is supported by a hard bone, a quarter of an inch in length, that serves as a ramrod for tunnelling. In all the mole's body there is nothing sticking out to interfere with life in tunnels—no outside ears, for instance, to scrape against the sides of the tunnels. His ears are but minute, well-protected holes ; but for all that he has a marvellous sense of hearing. An animal that lives for the most part in absolute darkness has little or no use for eyes ; and we find the mole's eyes are the tiniest points buried in the fur. Not least of the marvels of the mole is his thick, soft, silky blue-black fur, which, unlike the fur of all other mammals, grows out straight from his

body. Most other mammals' fur grows backwards, from head to tail—as you can see in a cat : if you stroke a cat from tail to head, the fur gets ruffled up and stands on end. Not so the mole's fur, which can be stroked down either way, from head to tail or from tail to head : it can lie close and flat to the body in either direction. What an advantage *this* is to an animal that lives as closely fitted in an earthen tunnel as a cartridge in a sporting rifle ! It means that the mole can walk backwards or forwards in his tunnel without rubbing his fur up the wrong way ! The legs of the mole are mostly *inside* the body, the parts that stick out being so short that they take up hardly any room in the tunnel. The forefeet turn *sideways* (outwards from the body) so as to dig away the sides of the tunnel. The forefeet, which do most of the shovelling work, are broad and bear strong nail-like claws, with a sickle-shaped " thumb " on the inside : all for digging. Finally, the strange, half-blind mole has a splendid set of teeth in his movable jaw—teeth for champing up the earthworms which suddenly appear during the digging operations. An encounter with an earthworm is the sole excitement in the mole's ordinary day . . .

The small molehills that lie so thickly scattered over open ground are " dumps " of earth excavated by this industrious mammal. The real molehill, in which the nest for the young is built, is a rather larger mound, usually hidden beneath a bush or away in the distant centre of a field.

The only other insectivora in Britain are the shrews.

**Common Shrew** (*Sorex araneus castaneus*). This little 2½ inch long animal, with a body one inch round, a flattish tail over an inch in length, with a long tapering nose from which grow a number of bristles, short legs with long-toed clawed feet, has a head not unlike a miniature hedgehog. The soft, short, velvety hair of this animal may be mouse-coloured, or brown, or almost black : it is often like those dark blue grapes that have a bloom on them. The small eyes of the shrew are almost concealed in the fur.

Living in ditches, hedge-bottoms and coppices, upon beetles, grubs of insects, butterflies, slugs, snails, earthworms, etc., the shrew is almost continuously on the hunt for prey, day and night, with short snatches of sleep between at any time.

The female makes her nest in a hollow in a hedge during the spring, summer or autumn. It is a carefully and cleverly made nest of grass or leaves, and is domed over. When the nest is made in a tussock of grass, the shrew very often bends down the growing blades of grass and laces them together over the nest to form the dome. There may be any number of babies from 4 to 10. They are born blind and hairless, but very quickly grow up. The mother may have more than one family in a year—how many is not known.

Like all mammals the shrews moult in the autumn—that is, change their coat of hair, the old coat falling off, a new coat growing in its place. The new autumn coat is a thick one for the winter, and this will be shed in the spring, when a summer coat will again grow. We have seen that birds have a similar moult of their feathers. It is an odd fact that the shrews do not moult in the second autumn of their lives; and consequently many thousands of these creatures perish of cold in their second year. However, the natural span of a shrew's life is but 14 months; and so it is supposed that their nature will "not go to the expense of winter clothing" when they will not live to wear it.

The little shrew is a bad-tempered creature and a cannibal; and this characteristic has given rise to the word "shrew" to describe any evil-spirited person. Although dogs, cats and foxes hunt shrews, they never eat them, for the flesh has an evil smell and a rank flavour.

**Pygmy Shrew** (*Sorex minutus*). The pygmy shrew is probably never more than two inches in length. Like a smaller edition of the common shrew, the pygmy has certain differences, such as a greater liking for night-life, and a longer tail in proportion to the body (the tail of the pygmy

shrew is about the same length as that of the common shrew).

**Water Shrew** (*Neomys fodiens*). The water shrew belongs to a different genus from that of the other shrews in Britain. He is our largest species of shrew, being about 4 inches in length—sometimes 5—with a tail of 2 to 2½ inches. The snout is broader and stronger than that of the other shrews. He is a marvellously beautiful animal to watch in the water. When swimming he uses the hind legs to propel himself along and the forefeet for steering (turning). Swimming rapidly on the surface of the water, with his body swaying this way and that as the legs work beneath the surface, the water shrew will suddenly leap in the air and dive beneath the stream after the tadpoles, water-beetles, caddis worms, and water snails, which form his chief food.

The water shrew makes a burrow in the bank, an underground cave which will have several entrances and exits, some above water and some beneath. In the cave she builds a nest, lined with soft grass, in which 5 or 6 babies will be born in May. They are blind and hairless at first but will be able to fend for themselves in 5 or 6 weeks. They are very playful creatures, and will chase one another up and down the little tunnels to the cave.

From the insectivora we come to the " gnawing animals " called **Rodentia.**

**Brown Hare** (*Lepus Europaeus*). The brown hare has no home. A creature of the open, he is not even born in a nest. When her 5 or 6 babies are born, the mother keeps them separate from one another. This is not so cruel and stupid an act as one may imagine, since, although these babies are left on the open earth, a prey to any hawk or owl, stoat or fox who may see them, the leverets, as the young hares are called, are born with their eyes open, and their bodies covered with hair, and they are able to run about almost from the first. And the hare is not only one of the fleetest of our mammals, but also one of the most intelligent. The

glorious stories of cunning " Brer Rabbit " are really tales of the hare told by the American Negroes, who call all rabbits and hares " rabbits." The real rabbit is a far more stupid animal than the hare.

See the hare pursued by dog or fox ! While he is streaking along at 35 miles an hour he can take a sudden side-leap of 15 feet. He will double-track in such fashion as to put a Boy Scout to shame. A good hare will run any ordinary dog to a standstill.

Hares never walk—that is, they never move their left and right legs alternately ; and, as might be expected from our account of those magnificent leaps, the hind-legs are enormously longer than the front ones, which are very short and slender. This kangaroo-like arrangement makes it difficult for hares to run *downhill* ; and if they attempt to do so, and the hill is steeper than they imagined, over they will go, head over heels.

The head and body of an adult brown hare measures about 24 inches, the tail being about 3 inches. A particular feature of the hare is the ears, which are 4 or 5 inches long, and can be cocked up for listening or laid back against the body for concealment or when in flight. In general the colour of the hare is reddish about the head, with tufts of darkish brown, the ears paler with black tips ; long black and white whiskers trail from each side of the nose ; the legs are yellowish brown, the underparts whitish, the back and sides covered with a double coat of short yellow-red woolly hairs set with longer hairs which are greyish on their lower parts and black at the tips. The tail, which is often curled up over the back, is black above, white below. There are differences in individual hares, and it should also be remembered that the hare moults and changes his tints and marking somewhat with the seasons.

Although he has no nest, the hare has a home called the " form." This is a mere beaten-down spot amid grass or other cover, and there may be one or two tracks leading from the form, made by the hare in his daily journeys in search of food. He is a vegetable feeder, preferring above

all things meadow-grass, sow thistles and dandelions ; but he will also eat cereals and vegetables.

Mountain Hare (*Lepus timidus*). This mammal is sometimes termed the blue hare, although his back, legs and chest are grey, and his underparts white. His winter coat is grey-white all over. He is found only in the higher mountains of England and Wales and is smaller than the brown hare. He is not so intelligent, although he can outwit a dog or a fox in the chase in spite of being not such a good runner as his brother of the valleys. The mountain hare feeds on grasses, rushes, heather, certain species of moss, etc., and is otherwise very like the common brown hare.

Rabbit (*Oryctolagus cuniculus*). The rabbit is not a native of Britain, but comes from Spain. He was brought into this country, like the pheasant, in fairly recent times, and has spread so that probably no open bit of country in Britain is without its rabbit population. As everyone *must* know a rabbit when they see one, we need not describe this rodent, though we may note that the rabbit is a much smaller animal than the hare, greyer in colour, with smaller ears and feet. Everyone knows, also, that the rabbit is a good second to the mole as a burrower ; but not many people have seen the rabbit burrowing with his forepaws and throwing back the loosened earth by kicking his long, strong back feet. The general plan of a rabbit warren is a tunnel about six inches round that goes in at one place and out at another. The home of the rabbit is always in a blind alley off this main tunnel. Rabbits, unlike hares, are sociable creatures, and gather in vast numbers in suitable places ; and in such places their warrens may be like some mad labyrinth. " Early in spring when the days begin to be warm the female rabbits leave the big burrows and excavate nurseries out of the way of other rabbits. . . . The doe (female rabbit) burrows into the ground for 2 or 3 feet and at the end of the burrow prepares a warm nursery. The nest is made of dry grass and is finally lined with wool which the

doe tears from her own flanks. It is very cosy and warm, and this is very necessary, because the rabbits come into the world hairless, blind and helpless. When the young are born the doe carefully scratches back the soil over the entrance, pads it down and completely blocks the opening. Even then the young are not safe from the fox or the badger. Both of these animals will dig them up, and then woe betide them. The mother never lies with her family, but having shut them up, retires to some considerable distance to feed and rest. In the waning light of the evening she returns, opens the burrow and gives the young rabbits their long-waited-for and much-desired meal. The maternal instinct warns the doe that it is safer to leave the young alone, as her presence might betray the nest to the many enemies which are ready to devour them."[1] For a month, young rabbits are unable to fend for themselves, but during that time the mother is prepared to defend them against all comers, using her powerful hind feet against the savage weasel or the fox.

Squirrel (*Sciurus leucourus vulgaris*). Once again, we come to an animal known to all ; but many people nowadays may confuse the common native squirrel of England with the grey squirrel brought into the country from America. Our English squirrel is deep copper-brown, his bushy tail being sometimes lighter in hue than the body. He looks as large as a rabbit or hare, at first glance ; actually he is not a third of the size of the brown hare. The squirrel is under eight inches in length ; it is his tail, which provides another seven or eight inches, that makes him look so much bigger than he really is. Although this tail is not prehensile he uses it as a rudder or even as a parachute in his acrobatic leapings from branch to branch and from tree to tree.

Both the male and the female squirrels build nests to live in called "dreys" : comfortable homes made of leaves, twigs, bark and moss, usually in the fork of a tree. These homes are completely roofed in, and there is often a porch over the doorway to keep out rain ! The dreys are not

[1] J. J. Simpson, *Chats on British Mammals (Rodents and Bats)*, p. 30.

hidden in any way, as is the nest in which the young are born. The female builds the breeding-nest—often in an evergreen tree, as she begins building before the leaves come out on deciduous trees. This nest is very carefully concealed. It is built on much the same plan as the drey, but is far more comfortable. The two to seven young are born in May or June. The squirrels, as everyone knows, prefer nuts to any other food, but will eat green shoots, leaves, berries, etc.

Dormouse (*Muscardinus avellanarius*). The name " dormouse " comes from *dormeuse*, the French for " sluggard " ; he is called sluggard because he is a most thorough hibernator. The first cold days of autumn send the dormouse into a hole in an old bank or tree, there to build a little round ball for a nest, which he will seal up from the inside, where he will curl up and go to sleep for months. Like the bat, the temperature of the dormouse falls to that of his surroundings during the winter sleep. Again like the bat, he has eaten and eaten until he is as fat as he can be ; but when he awakes in spring, he is a poor bag of bones, until he has had several meals. Like his cousin, the squirrel, he likes nuts, shoots and berries, but he will also eat caterpillars, leather-jackets and other insect-larvae.

Like the squirrels, the dormice in summer build themselves dreys (just like the squirrel's, but smaller, about the size of cricket balls), and the female builds a breeding-nest in which about four babies are born in August or September.

The adult dormice are about three inches long, with a tail of about two and a half inches. The fur is soft and thick and of a yellowish-brown colour with paler underparts. Even the tail is thickly furred. The large, bright brown eyes look out from a tiny squirrel-like face from which springs a fountain of white whiskers. The feet of the dormouse are pinkish.

He is a tree animal who seldom descends to earth. He is a short-lived creature, rarely living through two winters.

He is one of the cleanest wild animals in Britain, looking after himself with as much care as does a cat.

My own very first encounter with wild mammalian life was a fondness conceived for the **House-Mouse** (*Mus musculus*) when I was a bare five or six years of age. I used to have supper in a large nursery all alone. There was a mouse hole in the wall from which I used to lay a trail of crumbs to the table. I waited and watched for the mice to come out, and soon had their company on the table-top during my meal. Several of the small grey creatures would sit on their haunches beside my plates, nibbling my sponge cakes with an air of drawing-room politeness.

The mouse and the rat are perhaps insignificant creatures with which to begin an acquaintance with wild mammalian life ; yet they are the only forms, save a few town bats, which have survived to live with men in great cities, and their survival is not to be put down merely to their small size. They are extraordinarily cunning, persistent and brave creatures. I say brave, though we talk about being " as timid as a mouse " ; but the mouse knows that discretion is the better part of valour.

" The rats " (and mice) " discovered that by keeping close to man they were always in the neighbourhood of food, whether intended by man for himself or for his domestic animals ; and even these tame creatures would at times serve for the rats' meals. So when they found man loading ships with grain the rats " (and mice) " decided to go with him. Often they contrived to get into his bales of merchandise and so conveyed to the hold. If not, there were always mooring ropes which served as bridges from the quay to the vessel. And so they got themselves conveyed in comfort, sure that wherever the goods went there would be settlements of their biped friends to house them and serve their ends generally. Now, wherever man has established himself, you are almost certain that the rat is close at hand "[1]—to say nothing of the mouse.

Man may be the biped friend of rat and mouse, but by

[1] Edward Step, *Animal Life in the British Isles*, p. 98.

the same token rat and mouse are enemies of man, and I now realise the enormity of my offence in entertaining the grey mammals at my board. Man indeed is engaged on a defensive war against these small creatures, perpetually. They are the great pilferers, the spoilers of man's stores of fruit and grain. We have seen, too, that the rat may be a very serious enemy to mankind: in Chapter V, Book Three, we noted that the great historic plagues were carried by fleas that were carried by rats.

The forms of wild rat and mouse in Britain are far more numerous than many people suppose. They include the voles, field-vole (*Microtus agrestis*), and water-vole (*Arvicola amphibius*), the black and brown rats (*Rattus rattus* and *Rattus norvegicus*), the wood-mouse (*Apodemus sylvaticus*), the harvest-mouse (*Micromys minutus*), and several other forms, at which we must now look.

**Black Rat** (*Rattus rattus*). The so-called " black rat " is never black, but is of a blue-grey colour. Although nothing but a pest, the black rat is by no means a horrible-looking creature. A slender, silky-sided little body, seven inches in length, with a seven-and-a-half-inch tail, tapering and curled, a tapering, slim face, with a long delicate snout and white whiskers, with large upstanding ears, thin legs with clawed feet : such is the black rat ; and if he sounds to be no beauty, there is nevertheless beauty in his movements. A timid creature, clean in his habits and person, it would nevertheless be a magnificent thing if every one of his breed were killed off and his race were confined to that portion of central Asia whence his ancestors came. The black rat breeds several times a year, having seven to nine young ones in a litter. The young are born hairless, blind and helpless. They become fully grown in about three months.

**Brown Rat** (*Rattus norvegicus*). The black rat was the first rat to invade Britain, and was in possession of our barns and granaries for centuries before the brown rat came on

the scene. When the brown rats arrived[1] fierce battles took place between them and the black rats which resulted in the almost total extermination of the blacks, which are now not very numerous in this country, except in one or two seaport towns, the brown rats being the larger and fiercer of the two kinds. The brown rat is known by several names, house-rat, Norway rat (he is supposed to have come from Norway), common rat and sewer-rat being the most popular. A fully grown brown rat measures about nine inches, with a tail of seven or eight inches (held out straight, not curled as the tail of the black rat usually is). His body is rounder, his legs thicker, his face squarer, his brown fur coarser, than is the case with his black cousin. He is a less cleanly animal than the black rat, eats more and cares less what he eats : in other respects the habits of *Rattus norvegicus* are very like those of *Rattus rattus.*

The latest estimate of the rat population of England is fifty *million* : mostly browns ; and it is said that the damage done by these creatures every year amounts to £100 million. They are nocturnal animals, sleeping by day in nests made of paper, rags, grass or any suitable materials. As a rule nests are made near food supplies ; but then, they will eat absolutely anything : seeds, vegetables, fruit, garbage, dead bodies of animals and birds—they will even kill poultry, game birds, ducks, young rabbits, etc., and they will suck the eggs of fowls, game and other birds. Their principal food in the country is grain, of which they rob the farmer of immense quantities. In towns they will make homes for themselves in every sort of building, in shops, factories, warehouses and private houses. Great numbers of rats make their abode in the sewers of large cities and towns, where they thrive on the city's rubbish and increase and multiply rapidly ; and through the sewers they gain entrance to many types of building, setting themselves up under floors, in hollows in walls, etc.

Much damage is caused by rats to satisfy their need for gnawing. They will gnaw almost any hard substance, and

[1] They were first reported in England in 1728.

can easily gnaw through a wooden partition or floorboard in a night. They can even gnaw through lead pipes ; and disused pipes are one of their principal means of travel—though no obstacle seems too great for them to overcome : they are strong swimmers and climbers.

So man fights against the rat with every means in his power—with traps and with poisons ; by flooding and smoking out their hiding-places ; with the aid of ferrets, terriers and so on. But the ease and speed with which the rats reproduce their kind enables them to hold their own. In the country they have their natural enemies, the birds of prey and the owls, the crows, magpies, jays, the vipers and snakes, weasels, stoats, otters, hedgehogs. Man almost alone has to keep the "balance of nature" against rats in his cities.

**Field-Mouse** (*Apodemus sylvaticus*). It is pleasant to come from the rats, which are vermin, to the field-mouse, who, although he can become a pest, at any rate has much to be said in his favour, and is a pretty little animal. The field-mouse is never more than four inches long, with a tail about as long again. The upper parts of the field-mouse are a warm reddish brown varying to a yellowish grey, but long black hairs, especially down the middle of his back, rather dull the bright colour. The underparts are pure white with a brown or yellow spot on the chest. In shape, the field-mouse is very like the common house-mouse, although the ears are larger, broader and rounder, the backs of the ears having a coating of hair. The tip of the tail bears a tuft of long hair. The hind legs are longer, the hind feet larger, than are those of the house-mouse.

If you catch a field-mouse by the tail, he makes off leaving the skin of his tail in your hand—after the principle of our friend the prawn who snaps off the leg that you seized.

A creature of the hedgerows and the woodlands, where he feeds on cereals, grass-seeds, nuts, fruit and vegetables, the field-mouse makes nests of dry grass in a little burrow, or an old bird's nest, or the thick of rank grass, where five to nine

young are born. Six or seven families arrive between March and September.

**Harvest-Mouse** (*Micromys minutus soricinus*). Even those people who detest all rats and mice cannot help but be charmed by the delightful little harvest-mouse, one of the most fascinating animals in all of Britain's broad acres. Not more than 2 to 2½ inches long, with a tail of the same length, the harvest-mouse is a dumpier creature than his long-nosed cousins, with a shorter snout and a rounder body. Gilbert White said two harvest-mice just weigh down a halfpenny piece. One harvest-mouse does not weigh down a cornstalk, to the top of which he can climb without bending the stem. A little red-brown furry body with little ears set back in the fur and white underparts, the harvest-mouse has a prehensile tail, often hanging to a stalk by the tail, always coiling the tail round a stalk for support. An eater of cereals, and fond of tender young leaves, he will eat many sorts of insects, especially flies and woodlice. He is also carnivorous and not above being a cannibal. Breeding three or four times a year, with a family of six or eight each time, the nest of the harvest-mouse is one of the marvels of the countryside.

The harvest-mouse makes her nest out in the fields or in bushes, constructing it out of growing leaves which she does not pluck from their stems, but which she bends and twists and interweaves to form a living nest attached by nature to the plants amid which it is built. By splitting many of the leaves and rolling up the split pieces she forms lengths of cord to bind up the whole.

**Bank-Vole** (*Evotomys glareolus*). An animal of four inches with a tail of two inches, very mouse-like to look at, but woollier, of a rich chestnut-auburn colour (in winter much darker), greyish white beneath, with pink feet, and white whiskers, the bank-vole is found in a great variety of places : a burrowing animal, making a network of tunnels like the mole (not so extensive), the bank-vole can yet climb trees : found in open country, and also beside woods and hedges :

will eat all sorts of green stuff, fruits, grain, grass-seeds, vegetables, nuts, insects, snails, etc. Lays up a store of food for the winter. Nest made above ground in hedgerows or hayfields, of grass lined with moss, wool and feathers. Here, several times during the summer, families of six or eight hairless blind babies are born. In less than a week their eyes are open and they are covered with blackish hairs.

**Field-** or **Grass-Vole** (*Microtus agrestis*). Much like the bank-vole, though slightly larger and with a short stumpy tail, with rather greyer hair ; but the colour of this creature not only differs season by season but may be different in different districts. Is only a very clumsy and occasional tree-climber, and does not burrow so much as the bank-vole, but makes a snug underground retreat lined with dry grass. Builds a rougher nest and has not so many families per year as her long-tailed sister.

**Water-Vole** or **Water-Rat** (*Arvicola amphibius*). The water-vole has been called a field-vole who has taken to an aquatic life, and for this purpose has grown a longer tail, which he uses as a rudder, a thicker coat and thickly furred feet, the hair-fringes of which aid in swimming. The largest of our voles, with a head and body of eight inches and a tail about half as long, with a guinea-pig-like head, with ears hidden in the long fur and small black eyes, the water-vole is blue-black or slatey grey in colour (sometimes brownish). The thick hairs hold the air when the creature dives and give him a strange silvery appearance beneath the water.

An animal of the river-banks, rather helpless on land, making tunnels not unlike those of the mole. In these burrows are established living-quarters and a cosy breeding-nest, in which seven to nine babies may be born (not more than two families each year). Although both parents care for their children industriously, they never seem to teach the young to swim and many baby water-voles fall into the water and drown.

# CHAPTER X

## MAMMALS (2)

### (*Ungulata and Carnivora*)

ABOUT 2,000 years ago, when the whole of Great Britain was covered with forest, the wild red deer lived in countless thousands throughout the length and breadth of the land. As man cut down the forests in order to plant his cereals, the deer were driven to ever more distant retreats, and now they are found only in the extreme north of Scotland, in the high moors and deep woods of north Devon and west Somerset, in parts which it is not possible for men to cultivate. It is doubtful whether they would still survive in these places but for the sport of stag-hunting. Although red deer are to be found in more than eighty English parks, the park deer are semi-tame, whilst those of north Scotland, Devon and Somerset, are true wild animals, uncared-for and untamed by man.

**Red Deer** (*Cervus elaphus*). This magnificent creature, the largest of our wild animals, stands about four feet high at the shoulders, whilst his powerful neck and head may rise another foot, and the antlers which crown his forehead may spread apart three feet from tip to tip. The male red deer is called the stag or hart. The female is called the hind and is a trifle smaller : she wears no antlers. Let us follow the life-history of these majestic beasts.

The newly born deer, called a fawn, appears in May or June. There is generally one only, although twins are not unknown. The fawn is a reddish-brown creature, spotted all over with white. The mother hind, by a tap with the


RED DEER STAG
POLECAT
WEASEL
OTTER
FOX
HEDGEHOG
BRITISH
WILD MAMMALIA

forefoot, teaches the fawn to lie down flat, so that the little creature will not be seen by such foes as the wild-cat. If attacked, the hind will beat off enemies with her forefeet.

In a young stag the antlers begin to grow at the age of 8 or 10 months. They grow on both sides of the skull, above and a little behind the eyes. The small piece of bone which forms the base of each antler is called the *pedicle*. In the first year the antlers are straight, and grow to be about 4 to 7 inches long. During this stage the young deer is called a calf. In the second year he is called a pricket, a knobber, or a knobbler. In this year the antlers begin to put forth branches, the tips of which are called *points*. A stag should have 8 points when he is four years old, and 12 points when he is six years old. In the third year of his age he is called a brocket, in the fourth year a staggard or staggart, in the fifth year he is considered to be grown up and is called a stag.

A twelve-pointed pair of antlers is known as a *royal*. It is not usual in Scotland to find stags with more than 12 points, but among the Devonshire stags 14 points are common—called *imperials*. These antlers are shed and re-grown every year.

The stag sheds his antlers about March. They are generally shed on the same day each year. He feels that there is something wrong with his head and jerks about until first one and then the other antler snaps off and falls to the ground. After an antler-less month, the end of the pedicle begins to grow into a knob which is covered with skin and fur. This is very tender and makes the stag restless and ill-tempered. The antlers are not fully re-grown until the end of July, and are still covered with velvety fur, which peels off and hangs in strips during August. By the beginning of September the last of the fur has dropped and the new set of antlers is complete.

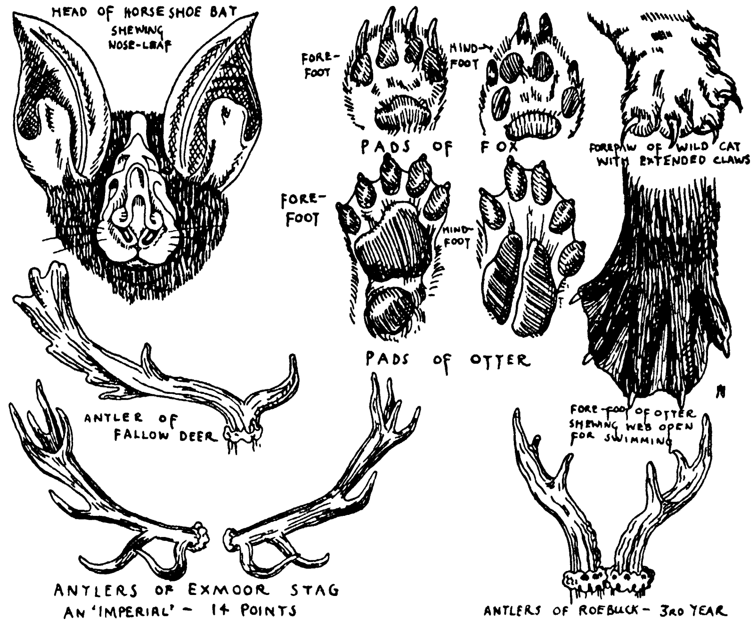
This shedding and re-growing of the antlers is not the only change through which the deer pass. Like all other mammals the red deer shed their coat twice a year. The summer coat is short and glossy, reddy gold upon the

back and sides, darker and duller on the legs, lighter and almost cream-coloured on the belly, the neck and the cheeks flecked with grey, the tail and back parts with a touch of white. Stags have a heavy mane on the jaws and neck, and there is a dark streak down the top of the neck and the middle of the back to the tail. Both stag and hind have long pointed ears that grow from the forehead, outside of and a little to the front of the antlers. The insides of these ears are whitish : they have black tips and edges.

In the late autumn the stags fight each other for the hinds. They fight by retiring from one another to a distance of perhaps 20 yards and then charging. The crash as they meet is terrific, and the roaring of the stags at this season may be heard two miles away.

The adult stag and hind are truly splendid animals. They are swift runners, they can take a leap of 20 feet and can swim half a dozen miles in the sea. Their food consists mainly of leafy shoots, beech nuts and acorns : they will also eat grass and fungi. They begin to grow old after 14 years, though a hind may live to be 20 and a stag may linger on to the age of 30 or thereabout.

Fallow Deer (*Cervus dama*). Wild fallow deer are found in several parts of Scotland and Ireland ; but they are practically in a wild state in the New Forest, Epping Forest and Rockingham Forest (Northamptonshire). The male of the fallow deer is called a buck, the female a doe, the young a calf. The antlers of the buck are not at all like those of the red deer. They are broad and flat and are shed in June and re-grown by August. The animal is smaller than the red deer, the buck standing about 3 feet at the shoulders. The colour of the fallow deer is a bright fawn, dotted irregularly with white spots. There is a black streak along the back and tail and a whitish line along each flank. The neck and belly are grey, the legs fawn, unspotted, the face grey-buff ; the tail has a dab of pure white on the under-side. In winter the white spots fade and the whole animal becomes more of one colour—a deep grey-brown.




**Roe Deer** (*Capreolus caproea*). Found only in a semi-wild state in the New Forest and a few other places, the roe is the smallest of our deer, the male standing about 2 feet at the shoulders. The male is called a roebuck, the female a doe, the young a fawn. The summer coat of the roe deer is a deep reddish auburn, with paler belly. The winter coat is much duller, though glossy. The antlers of the roebuck do not spread out, but grow up side by side from nearly the centre of the forehead. A fully grown roe-buck should have 4 points ; but there are sometimes 6. The antlers are shed in December and are re-grown by February.

Roebucks do not fight like stags and bucks. They generally are chosen by the does and live with them contentedly all their lives.

**Fox** (*Vulpes canis*). I have never hunted the fox, but I have seen many wild foxes : my first fox was hard-driven

by the hounds and ran across the road 10 feet from where I stood—a long, dark red creature, almost dead-beat, with tongue hanging out, every movement an effort for him ; but off he sped down the side of a ploughed field—I watched him for half a mile, until he vanished round the edge of a coppice. The hounds seemed to be further away : perhaps they had missed him : I was glad—although I knew that but for the sport of fox-hunting *Vulpes canis* would be extinct in our land. Because of fox-hunting, the fox remains a true wild animal, cunning, shy, fleeing from man and all his works. What a picture is presented by *Vulpes canis* !—lean body covered with rich golden red fur, his pointed ears tipped with black, his long thin red face splashed with white and black, his white chest, his dark slim legs, his great thick " brush " with its white tip twitching like the tail of a cat. Although the fox belongs to the dog family there are several things about him very cat-like—the pupils of his eyes, for instance, are not round like a dog's but oval, like a cat's : in the daytime the oval closes up almost to a slit, opening out to its fullest extent at night, thus enabling the fox, like the cat, to see best after nightfall.

For intelligence, the fox has no peer in the animal realm. For instance, if he discovers a nest of young rabbits he does not start digging at the mouth of the burrow, as a dog would do. No ; he finds out exactly where the nest is, and digs a new burrow straight down to the helpless babies, thus saving the labour of following all the twists and turns of the rabbit-burrow. Again, when the male (dog) fox has to feed the mother and babies, he will pack up the food neatly for easy carriage—tucking small birds under the wings of bigger ones, and so making a convenient parcel of them. But the cleverness of the fox is proverbial....

He also has a reputation for cruelty, and it is certainly true that he sometimes kills for the sake of killing. In this, however, he probably does more good than harm, since his victims include rats, mice, rabbits, voles, moles, shrews, birds, etc. Not all of these animals are harmful, but we have seen in the case of the first three the great rate at which

they multiply, and they would be likely to become pests were it not for such inveterate enemies as the fox. Stalking field-voles is the first training fox-cubs get for their life as hunters.

Fox cubs are born about the end of March or during April, 4 to 6 of them, in the " earth," as the burrow is called : this " earth " is generally not the work of the fox, but may be a rabbit burrow, obtained by the simple process of eating the original inhabitants. The burrows of the badger, also, are much favoured. The cubs are blind for ten days.

**Otter** (*Lutra vulgaris*). The otter is about a yard long, of which the tail is nearly one third. Formerly he was a land hunter, but gradually he took to a diet of fish. His body has now become perfectly adapted to an aquatic life. In order to offer the least possible resistance to the water when the animal is swimming below the surface the otter's head and face are flattened and the ears are very small. Both ears and nostrils can be closed to keep out water. The body is long, low and easily bent this way and that, almost as a fish twists, to assist the otter in the quick turns he has to take when chasing his prey in the streams. His short legs are loosely jointed. As he is the possessor of webbed feet, with five toes and short claws, the otter leaves a footprint quite unlike that of any other British mammal. The five toes and the marks of the claws or nails are always visible, sometimes a print of the heel can be noted, and an impression of the webbing is left on occasions. The long tail of the otter is flattened below and above and is called his " rudder " ; and the whole body is covered with two coats of fur, a thick under-fur for keeping out the wet when in water and an over-coat of stiffer and longer hairs. These outer hairs are greyish at the base, brown at the tips, and give the otter his brown-grey colour. The eyes are small and dark, and tufts of long stiff whiskers spring from the face.

When swimming slowly otters paddle in just the same manner as dogs, but when at top speed they lash the tail to and fro, driving their body through the water with a swaying motion. The main food of the otter is fish, and for this reason fishermen have waged relentless war against him in many parts of the country, although he kills off a great number of eels and so rids the fishermen of even worse enemies than himself. The otter, although so perfectly adapted to stream life, is by no means clumsy on land. He often travels great distances overland from river to river, and will attack and eat land animals and birds. It is in the water, however, that the otter is supreme. He can slip into a river without a splash, with hardly a ripple, and it is a wonderful thing to see him poised in a quiet stream, waiting for prey : he is as motionless as the stones on the bank, and nothing of him appears above water except the two small round nostrils through which he is breathing.

The life of the otter is an interesting study. A male and female otter will live together for life. Their home is usually a burrow in the river-bank with the entrance under water, though now and then they make inland burrows. The nest is lined with reeds and rushes. There is one family in the year, of three to five young, born in March or April. The young are as helpless as any babies in the animal world. They are blind for nearly three months, and for a longer time than that they can eat nothing but their mother's milk. During this time the father otter is kept extremely busy supplying the mother with food. When their eyes are opened the young are taught by their parents to swim and hunt. Ten years is an average time for an otter to live, though they may reach an age of 17 or 18.

Otter-hounds are kept in some districts for hunting the otter—especially in the south-west corner of England, where otters are most abundant. Otters have sometimes been tamed, and have made amusing, affectionate, and intelligent pets. They have been kept to hunt streams for fish for their owners.

**Badger** (*Meles taxus*). The badger is the only fair-sized wild animal in Britain who is not regularly hunted and yet manages to survive in considerable numbers. A very beautiful animal, three feet long, standing a foot high at the shoulder, with a reddish-grey body, darker below, very thickly furred, rather bear-like in build, with hunched back and stumpy tail, the badger may be found in every county in England, and one need look for him no further than a few miles out of the greatest cities. He is, however, strictly nocturnal in habits, and extremely difficult to watch. Once seen in a wild state, however, a badger is never forgotten. His long-nosed face is beautifully marked, a broad white band running over the head and forehead to the tip of the nose, two slim black triangles on either side of it, in which are the large bright black eyes and the white-tufted ears, while the cheeks are pure white again, with a white chin and black throat. Slow in his movements, not ferocious, the badger yet manages to live well on his extensive menu of fruits, roots, nuts, eggs, insects, young birds, rats, mice, and other small quadrupeds, frogs, snails, worms and such things as the honey of wild bees. The chief asset of the badger is his great strength, which resides more particularly in his long keen jaws—though his powerful, long-clawed feet are not to be despised. His feet play the chief part in the excavation of his magnificent burrow, which is called his "sett." Badgers will use the same setts generation after generation and some badger setts are known to be hundreds of years old. They resemble coal mines in having tunnels one above another with slanting tunnels between them. Some of these may be 100 yards in length. In spite of the age and size of these homes the setts of the badger are always clean : he is the cleanest wild animal in Britain, continually renews the bedding of the nest with clean dry grass, and has places in the open where he performs his morning toilet. A male and female badger live together for life, and are very affectionate. The cubs are born in February or March, three or four blind babes. Their eyes open in about a fortnight.

**Stoat** (*Mustela ermina*). The royal robes of England are adorned with ermine, which is the winter fur of stoats. The scarlet robes of peers, the capes of peeresses are likewise adorned with this fur. In the summer and the early autumn the general colour of the stoat is a reddish brown, but the throat, chest and underparts and the inner side of the legs are white or yellowish. The furry tail has a jet-black tip. But in the winter, all is changed. The stoat puts on a white robe—the ermine robe—and all *except the black tip of the tail* becomes as white as snow, though there may be tints of lemon-yellow, especially in the underparts.

The stoat is one of the rarest British mammals. His body is long, his legs are short, his movements almost snake-like. He is about a foot in length, the tail adding six inches. He is a most ferocious creature, swift and savage, as much at home in the trees, where he will attack birds and destroy their nests, as he is on the ground, where he will pursue the rabbits and rats into their burrows. He will attack a dog or a fox as calmly as he will a large game-bird. His way of attacking is to make a sudden leap at the throat of his victim.

Stoats nest in old walls, among ruins, in the roots of upturned trees, or even in rabbit burrows, often in very slight holes, which they line with leaves or grass. They have but one family in a year, of five or six blind babies, born about April. Almost as soon as their eyes are open stoats start their life of destruction. Families often hunt together in packs ; and in Scotland and other parts where they are more numerous many families will join together in a pack, to hunt like wolves.

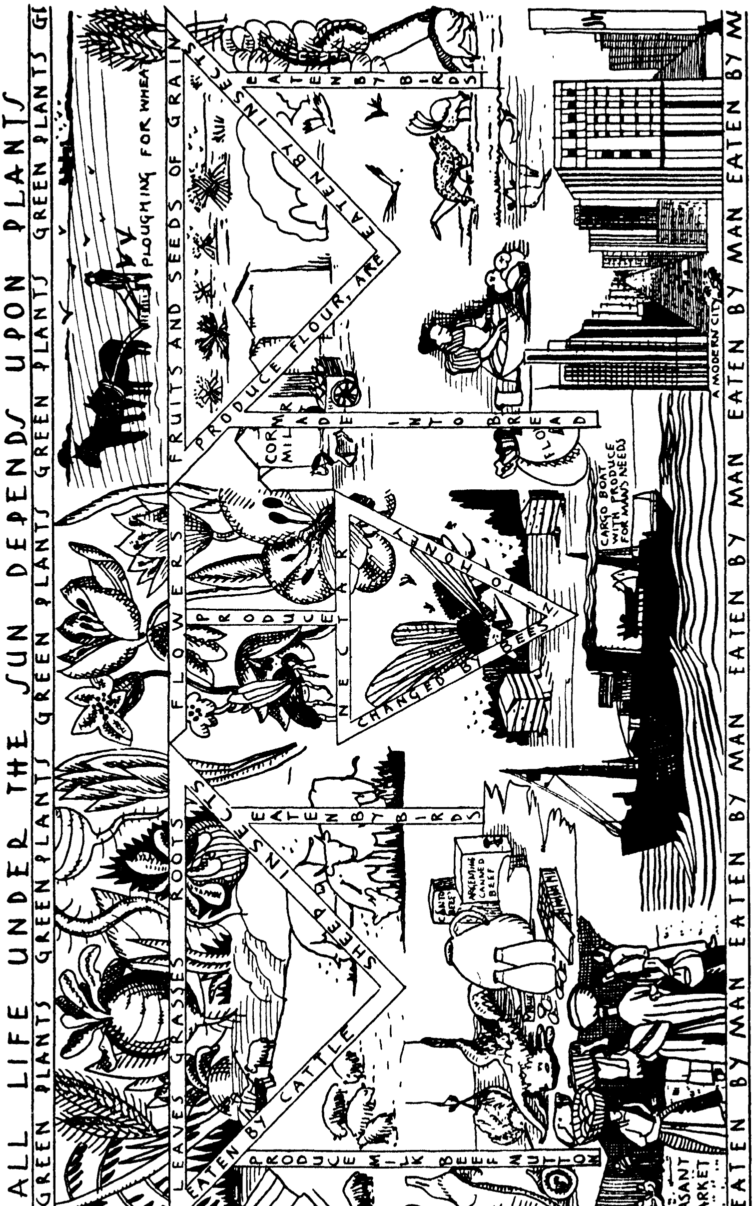
**Weasel** (*Mustela nivalis*). Very like the stoat in appearance, the weasel is smaller, about six or seven inches, with a two-inch tail that has *no black tip*. The neck of the weasel is longer in relation to the size of the body than is the neck of the stoat ; otherwise, in colour, shape, movements and ways of life, he is extremely like the stoat.

**Polecat** (*Mustela putorius*). Most people know the polecat through the ferret, who is a tamed albino polecat kept all over the country for hunting out rats, mice and other vermin (I have known them kept as pets, but they did not seem to me friendly beasts). Ferrets are of two kinds, the pure albino ferret being a yellowish white all over, the kind that is dark brown streaked with yellow being closer to the wild polecat from whom they have both sprung. The wild polecat is now found in only a few places in England and Scotland, but in greater numbers in certain districts of Wales. Over a foot in length, with a tail of six inches, the polecat is a ragged-looking creature, whose long yellow-brown fur always seems as if in need of a good brush. Very like the weasel and stoat in shape and ways of life.

**Pine-Marten** (*Mustela martes*). Weasel, stoat and polecat all belong to the same family, *Mustelinae*, and all three of them can have a most unpleasant smell. The pine-marten alone of the family is sweet smelling. There is nearly two feet of him, with a 12-inch tail attached. A handsome fellow he is with a chestnut or chocolate back, sides and head, with an orange or yellowish throat and chest. He is a tree creature preying upon squirrels and birds, breeding in tree nests, often birds' nests strengthened and re-lined. Two families of furry white babies, blind for three weeks, are born each year, about February and June. The pine-marten has a great liking for coniferous trees. He is now found only in the wilder, rockier parts of Britain.

**Wild-Cat** (*Felis catus*). Our fireside tabby is descended from an Egyptian species and has no connection with the wild-cat that still flourishes in the mountains of Scotland. It is quite a common thing for our tame cats to wander away into woods and go "wild"; but that is another matter. The true wild cat of Britain has longer and stronger limbs than the pet cat, and a longer body, being well over three and a half feet body-and-head.

Said never to have been tamed, called the fiercest of all


ALL LIFE UNDER THE SUN DEPENDS UPON PLANTS
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PLOUGHING FOR WHEAT
LEAVES GRASSES ROOTS FLOWERS FRUITS AND SEEDS OF GRAIN
EATEN BY CATTLE SHEEP
INSECTS EATEN BY BIRDS
PRODUCE MILK BEEF MUTTON
PRODUCE NECTAR
CHANGED BY BEES INTO HONEY
PRODUCE FLOUR, ARE EATEN BY INSECTS
EATEN BY BIRDS
CORN MILLED
MADE INTO BREAD
FLOUR
ARGENTINE CANNED BEEF
CARGO BOAT WITH PRODUCE FOR MAN'S NEEDS
A MODERN CITY
PEASANT MARKET
EATEN BY MAN EATEN BY MAN EATEN BY MAN EATEN BY MAN EATEN BY MAN EATEN BY MAN EATEN BY MAN

wild animals, living upon rabbits, hares, game birds, and countless smaller creatures, to say nothing of fawns and lambs, wild-cats hunt just before sunset and after dawn. They swim well, run swiftly, and leap upon their prey with lightning bounds and fierce cries, after stalking silently close up to their unsuspecting victim.

There are usually two to five kittens born in May ; but they may be born any time during the summer. They are cared for by their mother for three months, when they are able to fend for themselves.

# INDEX

*Heavy figures indicate illustrations*

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